APPENDIX M

GROUNDWATER MONITORING AND MITIGATION PLAN FOR THE CAPACITY REPLACEMENT PROJECT

Northwest Pipeline Corporation

Groundwater Monitoring and Mitigation Plan

Capacity Replacement Project

November 2004

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GROUNDWATER MONITORING AND MITIGATION

1.1 INTRODUCTION

This Groundwater Monitoring and Mitigation Plan outlines Northwest Pipeline Corporation's (Northwest's) proposed measures to determine if pipeline construction activities result in impacts to groundwater yields or water quality. The plan includes discussions relating to the identification of groundwater resources, a determination of susceptibility, and monitoring and mitigation to protect potable and non-potable groundwater sources.

1.1.1 Identification of Groundwater Resources

Northwest has completed the initial identification of groundwater wells and springs. Initial identification included communications with state, county and local agencies and searches of a groundwater well database maintained by the Washington State Department of Ecology. General locations of known or potential resources have been identified.

Final identification and confirmation of the existence and location of groundwater resources and identification of additional resources will be conducted through field investigations and contacts with landowners prior to construction. Landowners will be requested to identify groundwater supply wells and potable springs, identify the use of the well or spring (municipal, self-supplied, irrigation, industrial, or livestock). Ownership of the well/spring will be identified in consultation with the landowner or through appropriate agency records.

Landowners will be supplied with documentation explaining the field investigation, the proposed pipeline construction, and potential impacts on groundwater resources. The documentation will also indicate how the landowner can contact Northwest for further information. Landowners of wells and potable springs potentially susceptible to impacts will be advised that pre-construction monitoring is recommended to establish baseline water quality and yield. Landowners will be requested to give permission for Northwest to conduct the testing.

1.2.1 Determination of Susceptibility

Private groundwater supply wells and potable springs within 200 feet (400 feet for municipal water supplies) of the pipeline construction right-of-way or temporary extra workspaces will be considered potentially susceptible to impacts from proposed construction activities. These groundwater resources will be included in the monitoring program. Additionally, potentially impacted groundwater resources beyond the distances

mentioned above will also be monitored if unique construction activities (such as blasting) are required in the area.

During construction, landowners with water supplies located outside of the 200-foot monitoring area may request pre- and/or post-construction water sampling. In these cases, sampling would follow the same schedule and utilize the same methods described for water wells and potable springs located within the 200-foot monitoring area.

2.1 SAMPLING

Wells and potable springs for which landowner approval has been received will undergo pre-construction baseline sampling to establish baseline water quality and yield data. Northwest will attempt to schedule sampling activities at a time convenient to the landowner and in a manner that does not damage the resource. In the event that a source cannot be tested within the required schedule, a contingency agreement with the landowner will be negotiated.

Monitoring will be conducted on each well using the existing fitted pump and discharge line where possible. Testing will occur upstream of any water treatment system such as water softeners or purifiers. A submersible pump will be used to sample and test wells not fitted with operating pumps. Where there is a non-operating pump obstructing access, Northwest will request permission from the landowner to re-open the well to the extent required to insert a submersible pump. Springs will be tested at their source. Following testing, wells and springs will be restored to their pretest condition unless the owner requests otherwise (e.g. the landowner does not want a non-operating pump installed).

Prior to sample collection, the well or water system will be allowed to run in order to ensure that the water sample is representative of the aquifer. A minimum of three sets of temperature, pH, and conductivity readings will be taken at five-minute intervals. When these measurements become consistent, the well or water system is stabilized and ready for water sampling.

Water yield will also be determined at each location. Yield in gallons per minute (gpm) will be calculated using a container of known volume and a timer. Yield in gpm will be calculated by dividing the collected volume in gallons by the time in minutes required to fill the vessel.

2.1.1 Samples Collected for Laboratory Analysis

Water samples collected for water quality analysis will be tested for specific conductance, temperature, pH, turbidity, nitrate, fecal coliform and TPH. Northwest will also record date regarding water level or flow rate, horsepower of the existing pump, date and time, location, weather (if outside), and number of samples taken.

2.2.1 Methods of Sampling and Analysis

Sampling methods will adhere to the prevailing EPA and state sampling and analytical procedures in place at the time of construction. All samples will be collected and properly preserved so that they are delivered to a certified laboratory and tested within the holding times required by the EPA and applicable state groundwater quality standards.

2.3.1 Sampling Schedule

Water samples will be collected and yield will be calculated prior to construction to obtain baseline water quality and yield data for each sampling point. Northwest will conduct post-construction sampling as requested by the owner or for disputed situations, to determine the effects of construction on the water source. Sampling methods, locations, and analytical parameters of the post-construction sampling will be consistent with that of the pre-construction sampling.

3.1 MEASURES TO PREVENT WELL IMPACTS

Trench excavation will range from 6 feet to 8 feet in depth, which is too shallow to have a direct impact on the major aquifer systems underlying the proposed pipeline right-of-way, and no producing aquifers will be encountered at this depth.

Northwest has prepared a Spill Prevention, Containment and Countermeasures (SPCC) Plan that outlines proper storage, containment, and handling procedures to prevent the inadvertent release of fuels, solvents, or lubricants used during construction. The SPCC Plan also describes measures to be implemented by company personnel and contractors to prevent and control inadvertent spills of materials.

A review of bedrock depths indicates blasting will not be required during installation of project facilities. However, should blasting become necessary, Northwest would limit the blasting contractor to a peak particle velocity of 4 inches/sec at the location of an in-service pipeline (20 feet from the proposed pipeline). Based on this maximum allowed velocity the peak particle velocity at 45 feet would be approximately 2.0 inches/sec and 0.3 inches/sec at 150 feet. These limits should protect water wells and other nearby structures from any structural damage.

4.1 MITIGATION FOR WELLS IMPACTED BY CONSTRUCTION

Should it be determined after construction that there has been an impact on groundwater supply or water quality, Northwest will work with the landowner to ensure a temporary supply of water, and if necessary Northwest will replace a permanent water supply. Mitigation measure would need to be coordinated with the individual landowner in order

to meet the landowner's specific needs. However the likely solutions would be accomplished by providing potable water until a new well can be drilled, if necessary.

Within 30 days of placing project facilities in-service, Northwest will file a report with FERC regarding any landowner complaints received and the remedial action taken to address the complaint.

APPENDIX N

SITE-SPECIFIC VARIANCES TO THE FERC STAFF'S WETLAND AND WATERBODY CONSTRUCTION AND MITIGATION PROCEDURES

TABLE N-1

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
1481.02	S-9	PSS/R	A crossover was designed to avoid the creek encroachment on the east side of the right-of-way, which requires flipping the working side of the right-of-way at this waterbody crossing. The trench is expected to be excessively wide at the crossing due to the groundwater table, as well as the unconsolidated and saturated materials that would be excavated in the vicinity of the wetland. These conditions prevent vertical trenching and require the trench to be sloped off of vertical. The additional construction right-of-way width would also be necessary to contain the saturated spoil material because these materials generally spread out when they are stacked. Furthermore, the burial depth of the loop at the waterbody crossing and adjacent agricultural areas would be 5 feet compared to the standard 3-foot burial depth for non-agricultural uplands. With a 5-foot burial depth, the total trench depth would be approximately 9 feet assuming the 36-inch-diameter loop would be coated with several inches of concrete at the waterbody crossing.	Approved.
1480.93	S-10	PEM/PFO	The crossover location and side slope topography prevent necking down the construction right-of-way to less than 95 feet in this wetland.	Approved.
1480.01	S-16	R/PEM/PFO	The location of the North Pass Road open-cut crossing, the need for egress/ingress, as well as the location of a hydrostatic test break prevent necking down the construction right-of-way to less than 95 feet in this wetland.	Approved.
1476.80	S-27	PEM/PFO	The location of the Gilmore Road open-cut crossing, the need for egress/ingress, and the need to maintain residential access along an existing driveway prevent necking down the construction right-of-way to less than 95 feet in this wetland.	Approved.
1475.77	S-33	PEM	Necking down the construction right-of-way to minimize impacts on this emergent wetland (which is dominated by invasive species) would require the addition of temporary extra workspaces, which would affect residential tree screens. Impacts are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1475.75	S-34	PSS	Wetland S-34 is dominated by invasive shrubs (e.g., Himalayan blackberry). Necking down the construction right-of-way to 75 feet would not have a functional effect in minimizing wetland impacts. Impacts are expected to be temporary and short term (one growing season) because of the low quality condition of the wetland.	Approved.

TABLE N-1 (cont'd)

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
1475.19	S-39	PEM	The construction right-of-way would need to be greater than 75 feet wide in two areas within this wetland. One area is a disturbed emergent hayfield/pasture and the second area is at the crossing of an unnamed tributary. The first area (open-cut crossing of Wallace Lane) requires additional spoil storage and egress/ingress. In addition, the trench is expected to be excessively wide at the road crossing due to the high groundwater table and unconsolidated and saturated soils in the wetland area immediately adjacent to the road crossing. The trench would be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. In addition, the burial depth of the loop at the road crossing would be 5 feet compared to the standard 3 feet to compensate for traffic loads. Furthermore, the additional construction right-of-way width would be necessary to contain the expected saturated spoil material on the right-of-way because these materials generally spread out when they are stacked. Wetland S-39 is a low quality, disturbed emergent wetland and impacts associated with the wider construction right-of-way would be temporary and short term. To minimize disturbance to forested areas at the crossing of the Unnamed Tributary, no additional temporary extra workspaces are proposed; therefore, the additional construction right-of-way width would facilitate the tributary crossing.	Approved.
1472.56	S-53	PEM	Wetland S-53 is a low quality, highly disturbed wetland that is a pasture/hayfield. The construction right-of-way width would need to be greater than 75 feet in this wetland because the trench is expected to be excessively wide due to the high groundwater table and unconsolidated and saturated soils in the wetland. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. In addition, the burial depth of the loop at a driveway crossing would be 5 feet compared to the standard 3 feet to compensate for traffic loads at the road crossing. These conditions would require a wider construction right-of-way for greater spoil storage requirements. In addition, the wider construction right-of-way at this crossing would be necessary to contain the expected saturated spoil material on the right-of-way because these materials generally spread out when they are stacked. Wetland impacts associated with the 95-foot-wide construction right-of-way are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1470.83	S-58	PEM	Wetland S-58 is a low quality, disturbed wetland that is a pasture/hayfield and impacts from the project on this wetland would be temporary and short term (one growing season). Therefore, necking down the construction right-of-way width to 75 feet would not provide reductions in additional impacts on this wetland.	Approved.
1470.76	S-59 (Mitchell Creek – ditch)	R	The construction right-of-way runs parallel with this waterbody; therefore, a deviation and crossover were designed to minimize impacts on the stream. The deviation and crossover require the proposed 95-foot-wide construction right-of-way. Although the construction right-of-way overlaps the waterbody for approximately 180 feet, direct impacts on the waterbody channel would be minimized except at the actual pipeline crossing location.	Approved.

TABLE N-1 (cont'd)

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
1469.92	S-61	PEM	Wetland S-61 is a low quality, pasture/hayfield wetland. The trench is expected to be excessively wide in this wetland due to the high groundwater table and unconsolidated and saturated soils. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The proposed 95-foot-wide construction right-of-way in this wetland would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Impacts are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1469.80	S-62 (Trib. to Mitchell Creek)	R	Wetland S-62 (Trib. to Mitchell Creek) has been channelized and confined to a ditch. The alignment of the trench and the construction right-of-way prevent narrowing the construction right-of-way to 75 feet.	Approved.
1468.84 1468.81 1468.77	S-66 S-67A S-67B	R	The construction right-of-way width would need to be greater than 75 feet across these tributaries because the horizontal directional drill (HDD) entry point for the North Fork Nooksack River is immediately south of wetland S-67B. During the HDD, if the drill rig needs to be moved to the south side of the river, the drill stem pullback would need to extend down the right-of-way and around a curve. The wider construction right-of-way would be necessary to rope the drill stem around the curve in the easement and across the tributaries.	Additional justification needed. The Washing State Department of Ecology (WDOE) commented that the soils, vegetation, and hydrologic conditions in forested areas on either side of the pipeline right-of-way in this location should be evaluated and requested an explanation of how the variance would affect Northwest's ability to save the large trees adjacent to the existing cleared right-of-way in the event this variance is granted.
1466.62	S-77	PEM/PSS	The construction right-of-way width would need to be greater than 75 feet across a portion of wetland S-77 because the trench is expected to be excessively wide in this wetland due to the extensive length of the wetland, the high groundwater table, and the unconsolidated and saturated soils. The loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The proposed 95-foot-wide construction right-of-way in this wetland would be necessary to ensure that the construction activities and storage of saturated spoil material are contained on the right-of-way because saturated materials generally spread out when stacked. Wetland S-77 is a low-quality, disturbed emergent wetland that is an abandoned hayfield/pasture. Impacts on the wetland from the project would be temporary and short term (one growing season).	Approved.
1466.81 1465.83	S-76 S-78	PFO/PSS/ PEM/R	The trench is expected to be excessively wide because of the extensive length of the wetlands, the high groundwater table, and the unconsolidated and saturated soils. The loop would be	Approved.

TABLE N-1 (cont'd)

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
1465.62 1465.01	S-79 S-82		coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The proposed 95-foot-wide construction right-of-way in these wetlands would be necessary to ensure that the construction activities and storage of saturated spoil material are contained on the right-of-way because saturated materials generally spread out when stacked.	
1463.75	S-86A&B	PEM	A construction right-of-way width greater than 75 feet would be necessary through these wetland ditches because of the open-cut crossing of Homesteader Road and egress/ingress. The high groundwater table, saturated and unconsolidated materials, and 5-foot loop burial depth at the road crossing require the additional construction right-of-way width. These conditions create the potential for the trench to be excessively wide, and the saturated materials would need additional area to be stored. Impacts on these wetland ditches would be temporary and short term because they are low quality, artificial conveyance systems.	Approved.
1463.26	S-88	R	This tributary is a 2-foot-wide intermittent waterbody. Narrowing the construction right-of-way width to 75 feet would not benefit habitat conditions of this tributary, which does not support fish.	Approved.
1429.30	MV-2	PEM	The construction right-of-way width was necked down to 85 feet, but side slopes prevent necking the construction right-of-way width down to 75 feet.	Approved.
1428.74	MV-6	PEM	Staging for steep slope construction immediately to the north of this wetland prevents narrowing the construction right-of-way width to 75 feet. The wetland at the crossing is also a previously disturbed emergent wetland within the pipeline right-of-way and adjacent powerline corridor. Impacts are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1421.19	MV-24	PEM	Wetland MV-24 is a disturbed emergent wetland dominated by reed canarygrass and the construction right-of-way width would need to be greater than 75 feet at a ditch that is about 6 feet wide. Impacts are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1419.33	MV-32A, B	PSS/PEM/ PFO	Because of the extensive length and saturated/open water characteristics of the wetland in this area, the construction right-of-way width would need to be greater than 75 feet between mileposts (MP) 1419.65 and 1419.31. A crossover was included in the design because the trench is expected to be excessively wide from excavating saturated unconsolidated materials. The crossover would offset the proposed 36-inch-diameter loop 30 feet west of the existing 26-inch-diameter pipeline and outside Northwest's existing permanent easement, which requires Northwest to acquire 30 feet of new permanent easement. In addition, Northwest would utilize the existing 75-foot-wide permanent easement and 20 feet of temporary right-of-way to install the crossing for a total construction right-of-way width of 125 feet. Because of expected saturated and unconsolidated conditions, the construction right-of-way would need to be greater than 95 feet wide through two additional areas within wetland MV-32B (near MPs 1419.06 and 1418.79). However, these areas occur within previously	Approved.

TABLE N-1 (cont'd)

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
			disturbed/cleared areas within the loop and powerline corridor and support primarily emergent vegetation.	
1418.62	MV-32.2	PEM	The areas of wetland MV-32.2 that would be disturbed would be within the existing pipeline right-of-way and a parallel road easement that supports disturbed emergent wetland conditions. Necking down the non-working side of the construction right-of-way would not be practical in this area because the parallel road would be used as egress/ingress. Additionally, necking down the working side of the right-of-way would not effectively reduce impacts on the wetland because of its configuration, which narrows to a small point on the west edge of the construction right-of-way. Impacts are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1416.51	MV-41	PAB/PEM/ PSS/PFO	The construction right-of-way width would need to be 95 feet through this wetland system because of its extensive length and saturated/open water characteristics. Because of these conditions, the proposed 36-inch-diameter loop has been offset 30 feet east of the existing 30-inch-diameter pipeline because the trench is expected to be excessively wide from excavating saturated unconsolidated materials.	Additional justification needed. The WDOE commented that alternative means of reducing the construction right-of-way width, including constructing during the dry season, locating spoil piles outside of the wetlands, and using construction methods that limit the width of the pipeline trench should be evaluated. The WDOE also commented that additional impacts on forest and scrub-shrub wetlands that would be affected by the increased construction right-of-way width in the event this variance is granted should be identified.
1411.55	MV-59A	PEM	A 95-foot-wide construction right-of-way would be necessary through this wetland system because of its length, a high groundwater table, and the saturated, unconsolidated characteristics of the material to be excavated. Because of these conditions, the trench is expected to be excessively wide. Impacts would be temporary and short term because this wetland is previously disturbed and emergent.	Approved.
1411.06	MV-62	R	A 90-foot-wide construction right-of-way would be required for the flumed crossing of Little Pilchuck Creek. The proposed construction right-of-way width would be required to ensure adequate construction workspace to properly install the flume and in the event the trench width becomes excessively wide during the crossing due to the high groundwater table.	Approved.
1409.26	MV-67A	POW/PEM	A 95-foot-wide construction right-of-way would be necessary through this wetland system	Approved.

TABLE N-1 (cont'd)

Variances Requested for Construction Right-of-Way Widths Greater Than 75 Feet

Milepost	Wetland	Cowardin Type [a]	Variance Rationale	Approval Status
			because the trench is expected to be excessively wide. The trench would be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The increased right-of-way would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Impacts would be temporary and short term (one growing season) because of the emergent and previously disturbed condition of the wetland.	
1383.66	SN-42	PSS	A 95-foot-wide construction right-of-way would be necessary through this wetland system because of its length and because the trench is expected to be excessively wide. The trench would be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The increased right-of-way would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Impacts would be temporary and short term (one growing season) because of the previously disturbed condition of the wetland.	Approved.
1328.71	FL-17	R/PEM	A 95-foot-wide construction right-of-way across Lacamas Creek would be required because of the high groundwater table in the floodplain and the potential for the trench to be excessively wide during the flumed crossing. Lacamas Creek is a channelized tributary within an agricultural field and has no functional riparian habitat; therefore, impacts would be minor.	Approved.
1324.29	FL-35A, B	R	It is not feasible to construct an open-cut crossing of the Nisqually River within a 75-foot-wide construction right-of-way. At the river, Northwest's existing 30-inch-diameter pipeline is offset 50 feet to the east of the existing 26-inch-diameter pipeline, and the proposed 36-inch-diameter loop would be offset 35 feet to the east of the 30-inch-diameter pipeline. The offset of the loop would be necessary to ensure that the existing pipelines are not destabilized during excavation in the stream and to prevent heavy equipment from working over them. No in-stream work is proposed over the existing pipelines, except for potential spoil storage.	Approved.
1316.73	FL-52	PEM/PSS	Side hill topography requires a 95-foot-wide construction right-of-way through this wetland.	Approved.

[a] Wetland types according to Cowardin et al. (1979):
PFO = palustrine forested
PSS = palustrine scrub-shrub
PEM = palustrine emergent
POW = palustrine open water
PAB = palustrine aquatic bed
R = riverine

TABLE N-2

Variances Requested for Temporary Extra Workspaces (TEWS) Located Less Than 50 Feet From Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1482.80 1482.81	S-4B	R/PEM	S-TEWS-10.5 S-TEWS-11.5	Steep incised banks and the location of the crossing of Saar Creek prevent locating workspace S-TEWS-10.5 and S-TEWS-11.5 50 feet from the waterbody.	Approved.
1480.93	S-10 & S-11	PEM/PFO	S-TEWS-17.3	Location of a crossover, wetland S-11, and side slope topography prevents locating workspace S-TEWS-17.3 50 feet from this wetland.	Approved.
1480.06	S-15	PSS	S-TEWS-19	Side slope topography and the location of the open-cut crossing of North Pass Road prevent locating workspace S-TEWS-19 50 feet from the wetland.	Approved.
1479.06	S-21	PFO/PEM	S-TEWS-24	The location of the crossover, which would be necessary to avoid a home, and the need to flume Kinney Creek prevent locating workspace S-TEWS-24 50 feet from the wetland.	Approved.
1476.80	S-28	PEM	S-TEWS-40	Wetland S-28 is a low quality, abandoned pasture/hayfield that supports a monotypic stand of reed canarygrass. Workspace S-TEWS-40 would be required for an open-cut crossing of a driveway.	Approved.
1474.70	S-42	PEM/PSS	S-TEWS-64	Workspace S-TEWS-64 would be required for side slope construction and the topography prevents locating this workspace 50 feet from wetland S-42.	Approved.
1473.70	S-47	R	S-TEWS-74 S-TEWS-75	These workspaces would be necessary for the crossing of wetland S-47 (Trib. to Sumas River). Workspaces cannot be located on the north side of the creek because of steep slopes; therefore, workspaces S-TEWS-74 and S-TEWS-75 must be located on the south side of the creek. The minimum 5-foot depth of cover over the pipeline at the tributary requires both of these workspaces to be located as close to the creek as possible. Workspace S-TEWS-75 would be located in an emergent area that has been previously cleared and would not disturb any functional riparian habitat.	Approved.
1472.22	S-54 (Smith Creek)	R	S-TEWS-87	Workspace S-TEWS-87 would be necessary for spoil storage for the crossing of Smith Creek, as well as the unnamed road crossing. The unnamed road cannot be closed during construction because it provides access to several residences. Setting the workspace farther from the road crossing would not be feasible because of the proximity of the industrial building on the north side of the road.	Approved.
1469.16 1469.14	S-64	PEM/R	S-TEWS-122 S-TEWS-124 S-TEWS-125 S-TEWS-126 S-TEWS-128 S-TEWS-130	These workspaces would be necessary for the open-cut crossing of Marshall Road, the crossing of wetland S-64 (Unnamed Tributary), and steep slope construction. The alignment of the construction right-of-way in relation to the wetland, road crossing, and steep slopes prevents locating these workspaces 50 feet from the wetland. Workspaces S-TEWS-124 and S-TEWS-125 would be located in upland pasture and would not disturb functional riparian habitat.	Approved.

TABLE N-2 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Less Than 50 Feet From Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1468.10	S-71	PFO	S-TEWS-139	Workspace S-TEWS-139 would be necessary for egress/ingress and to abandon the 26-inch-diameter facilities at the existing aboveground facility located immediately adjacent to wetland S-71. This workspace would primarily be located on an existing access road to Northwest's aboveground facility.	Approved.
1467.06	S-75	PEM/PSS	S-TEWS-145	Workspace S-TEWS-145 would be necessary for egress/ingress onto Carroll Road. However, the road is located between the workspace and the wetland, which prevents the use of a 50-foot buffer adjacent to the wetland. The workspace would be 30 feet from the wetland.	Approved.
1463.26	S-88	R	S-TEWS-164.1	Although workspace S-TEWS-164.1 would be located within deciduous forested vegetation, this vegetation provides little riparian benefit to wetland S-88, which is an intermittent ditch tributary that does not support fish and is expected to be dry at the time of the crossing. Therefore, setting the workspace 50 feet from this ditch drainage does not provide functional benefit to the waterbody.	Approved.
1423.49	MV-16	PEM/POW/R	MV-TEWS-43	Workspace MV-TEWS-43 would be required for the South Fork Stillaguamish River HDD exit point. This workspace would be located almost entirely in previously disturbed farmed uplands. However, a narrow row of shrubs borders the wetland on the edge of the workspace. Northwest would attempt to avoid disturbing these shrubs during the HDD.	Approved.
1422.24	MV-20	PSS	MV-TEWS-54	The configuration of wetland MV-20 prevents locating workspace MV-TEWS-54 more than 50 feet from the wetland. This extra workspace is necessary to cross the tributary. Setting the workspace back 50 feet would make the workspace unusable, and the workspace would then be less than 50 feet from wetland MV-21.	Approved.
1422.22	MV-25	PEM	MV-TEWS-56 MV-TEWS-57	These workspaces would be necessary for the open-cut crossing of 212th Street NE and for egress/ingress. Workspaces MV-TEWS-56 and MV-TEWS-57 would be located 30 and 40 feet, respectively, from the wetland, which is an isolated, low quality disturbed emergent wetland dominated by reed canarygrass.	Approved.
1419.65	MV-32A, B	PSS/PEM	MV-TEWS-65 MV-TEWS-66	Workspaces MV-TEWS-65 and MV-TEWS-66 would be required for the crossover located at MP 1419.65 and to cross the extensive wetland system at this location. These workspaces cannot be set back 50 feet from the wetland based on the location of the crossover and the saturated/open water condition at the north end of this wetland.	Approved.
1419.34	MV-32A	PFO	MV-TEWS-68	Workspace MV-TEWS-68 would be required for a crossover. The steep side slopes in the area would prevent the workspace from being set back 50 feet from the wetland.	Approved.

TABLE N-2 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Less Than 50 Feet From Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1419.12	MV-32A, B	PFO	MV-TEWS-71	Workspace MV-TEWS-71 would be required for egress/ingress and intersects the right-of-way and wetland system less than 50 feet from the wetland.	Approved.
1411.35	MV-61	PFO	MV-TEWS-130.1	Workspace MV-TEWS-130.1 would be required for the road bore of Highway 92. Although this workspace would be less than 50 feet from wetland MV-61, it would be located entirely within the highway easement and primarily within previously disturbed areas.	Approved.
1411.06	MV-62	R	MV-TEWS-141 MV-TEWS-143	Because of the alignment of the creek with the construction right-of-way, workspaces MV-TEWS-141 and MV-TEWS-143 cannot be located 50 feet from the waterbody. These workspaces would be necessary because of the high groundwater table in the floodplain. The trench may become excessively wide and the workspaces would ensure that all activities are confined to the construction work area.	Approved.
1408.79	MV-71	PSS/PEM/ PFO	MV-TEWS-178	Workspace MV-TEWS-178 would be required for egress/ingress both during construction and operation because a new permanent access road (MV-PAR-1) would be installed to access the pig receiver and mainline valve at MP 1408.80. The alignment of MV-PAR-1 was selected to avoid permanent impacts on wetland MV-71.	Approved.
1390.20	SN-22	R	SN-TEWS-20 SN-TEWS-21	Workspaces SN-TEWS-20 and SN-TEWS-21 would be required for the crossing of Struve Creek (wetland SN-22). The confined construction right-of-way (60 feet in width) and side sloping topography on either side of the waterbody require these workspaces to be located less than 50 from the waterbody banks. The workspaces have been set back more than 10 feet from the wetland boundary.	Approved.
1385.47	SN-39.4	POW	SN-TEWS-57	Workspace SN-TEWS-57 would be required to cross Union Hill Road NE and for egress/ingress. This workspace cannot be located 50 feet from wetland SN-39.4 and still be functional for the road crossing.	Approved.
1328.12	FL-21	PEM/PSS	FL-TEWS-36	Workspace FL-TEWS-36 would be required for the open-cut crossing of 40th Avenue S/Hawk Peterson Road and for egress/ingress. This workspace cannot be located 50 feet from the wetland and still be functional for the road crossing.	Approved.
1316.73	FL-52	PSS/PEM	FL-TEWS-97	Workspace FL-TEWS-97 would be required for egress/ingress. Because of side hill topography in the area, the workspace cannot be located 50 feet from the wetland but instead would be located immediately adjacent to the wetland (which would also be disturbed by the construction right-of-way).	Approved.

TABLE N-2 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Less Than 50 Feet From Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status

[a] Wetland types according to Cowardin et al. (1979):
PFO = palustrine forested
PSS = palustrine scrub-shrub
PEM = palustrine emergent
POW = palustrine open water
PAB = palustrine aquatic bed
R = riverine

TABLE N-3

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1484.34	S-1	PEM	S-TEWS-2	Workspace S-TEWS-2 would be located in a low quality, farmed wetland at a hydrostatic test water discharge location, and would be needed for equipment staging, mobilization, and demobilization.	Approved.
1483.86	S-2	PEM	S-TEWS-6	Workspace S-TEWS-6 would be located in a low quality, deeply incised roadside wetland ditch and would be needed because of the presence of a foreign line crossing and for egress/ingress.	Approved.
1480.73	S-12	PEM/PFO	S-TEWS-17.1	Side slope topography and staging for steep slope construction prevent locating workspace S-TEWS-17.1 outside the wetland.	Approved.
1480.01	S-16	R	S-TEWS-21	The location of the open-cut crossing of North Pass Road prevents locating workspace S-TEWS-21 outside the wetland.	Approved.
1477.60	S-23	R	S-TEWS-33 S-TEWS-34	The sand and small gravel bed materials of Swift Creek require the proposed loop to be offset 40 feet from the existing 30-inch-diameter pipeline because the trench width at this crossing is expected to become excessively wide, which could affect the potential stability/integrity of the existing 30-inch-diameter pipeline. Offsetting the proposed loop requires placing workspaces S-TEWS-33 and S-TEWS-34 in wetland S-23 (Swift Creek). The existing stream channel at the crossing is disturbed and confined to dikes to facilitate removal of sediment from annual gravel mining operations.	Approved.
1475.46	S-37	PEM	S-TEWS-58	Workspace S-TEWS-58 would be necessary for staging and would be located in a low quality, disturbed emergent wetland that is an abandoned hayfield/pasture to avoid impacts on residences and forested areas. Other staging areas in the vicinity are not available because of the limited access, extent of adjacent wetlands, and residential and forested areas. The wetland is expected to be dry in the late spring and summer during construction. Although the wetland would be temporarily affected, it is expected to be fully restored functionally within one growing season.	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1475.19	S-39	PEM	S-TEWS-60	Workspace S-TEWS-60 would need to be located within wetland S-39 because of the open-cut crossing of Wallace Lane, the need for additional spoil storage, and egress/ingress. The trench is expected to be excessively wide at the road crossing because of the high groundwater table and unconsolidated and saturated soils in the wetland area immediately adjacent to the road crossing. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. In addition, the burial depth of the loop at the road crossing would be 5 feet compared to the standard 3 feet to compensate for traffic loads. Wetland S-39 is a low quality, disturbed emergent wetland and impacts associated with the project would be temporary and short term. The location of workspace S-TEWS-60 was placed on the south side of Wallace Lane to avoid forested wetland impacts and residential tree screens on the north side of the road.	Approved.
1474.77	S-41	PFO	S-TEWS-62	Workspace S-TEWS-62 would be necessary to install a prefabricated fitting at the sharp PI that would require additional excavation and spoil storage. The location of the PI and the adjacent steep slopes prevent locating this workspace outside of wetland S-41. This workspace would be located primarily in immature deciduous forested areas (alders) and would not disturb mature trees. Impacts on the wetland from this workspace would be temporary and minor. Northwest would replant the forested wetland according to the Washington State Department of Natural Resources Forest Practices Act.	Approved.
1474.77	S-41	PEM	S-TEWS-63	Workspace S-TEWS-63 would be located entirely within Northwest's abandoned pipeline corridor for the 26-inch- and 30-inch-diameter pipelines and would be partially located within wetland S-41, which is a disturbed emergent wetland dominated by reed canarygrass. This workspace would be needed for staging for steep and side slope construction both to the north and south of this location.	Approved.
1474.70	S-29	PEM	S-TEWS-42	Workspace S-TEWS-42 is necessary for the crossings of the Trib. to Sumas River. The construction right-of-way would impact most of the wetland; only 0.01 acre of wetland S-29 would be affected by this workspace. This impact would not affect the functions of this low quality wetland that supports a monotypic stand of reed canarygrass.	Approved.
1472.56	S-53	PEM	S-TEWS-82 S-TEWS-83	Wetland S-53 is a low quality, disturbed pasture/hayfield wetland. Workspaces S-TEWS-82 and S-TEWS-83 would be needed for staging for steep slope construction, an open-cut driveway crossing, and the wetland crossing. The trench is expected to be excessively wide at the driveway crossing because of a high groundwater table and unconsolidated and saturated soils in the wetland area. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
				increases the overall pipe diameter. The burial depth of the loop at the road crossing in the wetland would be 5 feet compared to the standard 3 feet to compensate for traffic loads at the road crossing, which also increases the trench width. The location of these workspaces in wetland S-53 would be necessary to ensure that the saturated spoil stored for the driveway and wetland crossings would be contained on the right-of-way because these saturated materials generally spread out when stacked. Impacts on this wetland are expected to be temporary and short term (one growing season).	
1470.83	S-58	PEM	S-TEWS-100	Workspace S-TEWS-100 would be necessary for staging and spoil storage for the crossing of wetland S-57.1 (Trib. to Mitchell Creek). Wetland S-58 is a low quality, disturbed pasture/hayfield wetland and locating the workspace in the wetland would not disturb any functional riparian or wetland habitat. Impacts on this wetland are expected to be temporary and short term (one growing season).	Approved.
1470.14	S-60	PEM	S-TEWS-113	Workspace S-TEWS-113 would be needed for spoil storage associated with the reverse loop installation between MPs 1470.35 and 1470.02 that would be required for the crossover in this area. The spoil is also expected to be saturated because of a high groundwater table in the vicinity of the wetland and would require additional area for storage because these saturated materials generally spread out when stacked. Impacts on this wetland from project activities are expected to be temporary and short term (one growing season) because of the low quality, emergent condition of the wetland.	Approved.
1469.92 1469.80	S-61 S-62 (Trib. to Mitchell Creek)	PEM/R	S-TEWS-115 S-TEWS-118	Wetland S-61 is a low quality pasture/hayfield wetland and wetland S-62 (Trib. to Mitchell Creek) has been channelized and confined to a ditch (wetland S-63). The alignment of the trench and the construction right-of-way makes it infeasible to locate workspace S-TEWS-115 outside the wetland. The trench is expected to be excessively wide in these wetlands because of a high groundwater table and unconsolidated and saturated soils in the wetland area. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The locations of workspaces S-TEWS-115 and S-TEWS-118 would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Impacts on these wetlands are expected to be temporary and short term (one growing season).	Approved.
1469.00	S-65	PEM	S-TEWS-132 S-TEWS-133 S-TEWS-134	Wetland S-65 is a low quality pasture/hayfield wetland and these workspaces would be necessary for the bored crossing of the Mount Baker Highway. These workspaces cannot be placed outside the wetland because of the length and location of the wetland immediately adjacent to the highway.	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1468.84 1468.81 1468.77	S-66 S-67A S-67B	R	S-TEWS-131	Workspace S-TEWS-131 would be the entry point for the North Fork Nooksack River HDD. Because it may be necessary to move the drill rig to the south side of the river during the HDD, the drill stem pullback would need to extend down the easement to the north and across the waterbodies (intermittent - 2 feet wide) within this workspace. The curve in the alignment may prevent the drill stem from being confined to the existing easement; therefore, workspace S-TEWS-131 would be necessary to rope the drill stem around the curve of the easement and across the tributaries.	Approved.
1466.62	S-77	PEM/PSS	S-TEWS-147 S-TEWS-148	Workspaces S-TEWS-147 and S-TEWS-148 would need to be located within wetland S-77 because of the open-cut crossing of Potter Road and the need for additional spoil storage and egress/ingress. The trench is expected to be excessively wide at the road crossing because of the high groundwater table and unconsolidated and saturated soils in the wetland area immediately adjacent to the road crossing. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. In addition, the burial depth of the loop at the road crossing would be 5 feet compared to the standard 3 feet to compensate for traffic loads at the road crossing. The locations of workspaces S-TEWS-147 and S-TEWS-148 would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Wetland S-77 is a low-quality, disturbed emergent wetland that is an abandoned hayfield/pasture. Impacts on the wetland from the project would be temporary and short term (one growing season).	Approved.
1465.83	S-78	PEM/PSS/ PFO	S-TEWS-152	Workspace S-TEWS-152 would be necessary for additional staging because of the extensive length of this wetland (approximately 2,000 feet).	Approved.
1465.01	S-82	PFO/R/PEM	S-TEWS-157 S-TEWS-158	The trench is expected to be excessively wide in this wetland because of a high groundwater table and unconsolidated and saturated soils in the wetland. The trench would also be wider because the loop would be coated with several inches of concrete to compensate for pipe buoyancy in the wetland, which increases the overall pipe diameter. The locations of workspaces S-TEWS-157 and S-TEWS-158 would be necessary to ensure that the saturated spoil stored in the wetland would be contained on the right-of-way because these materials generally spread out when stacked. Workspace S-TEWS-158 would also be necessary for the open-cut crossing of Strand Road.	Approved.
1464.72	S-83	PEM	S-TEWS-160	The location of the crossover in this wetland prevents workspace S-TEWS-160 from being located outside of wetland S-83. No other suitable upland areas are available in the vicinity to locate the crossover outside wetlands. Wetland S-83 is a low quality, disturbed wetland pasture; therefore, impacts on this wetland are	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
				expected to be temporary and short term (one growing season).	
1463.74	S-86A&B S-87	PEM	S-TEWS-160.2 S-TEWS-160.3	Workspaces S-TEWS-160.2 and S-TEWS-160.3 would be required for the open-cut crossing of Homesteader Road and for egress/ingress. The expected high groundwater table and saturated and unconsolidated materials as well as the 5-foot loop burial depth at the road crossing require the workspaces to traverse these wetland ditches. The soil and groundwater conditions create the potential for the trench width to become excessively wide, and the saturated spoil materials would require additional area for storage because they typically spread out when stacked.	Approved.
1463.01 1463.00	S-89A, B	PEM	S-TEWS-165 S-TEWS-166	Workspaces S-TEWS-165 and S-TEWS-166 would be required for the open-cut crossing of Wildrose Road and for egress/ingress. The 5-foot loop burial depth at the road crossing requires that these workspaces be located across the wetland ditches. These low quality wetland ditches support few wetland functions except for surface water conveyance. Impacts on the wetland ditches would be temporary and short term, lasting only for the duration of construction. The ditches would be fully restored after construction.	Approved.
1428.62	MV-7	R	MV-TEWS-11	Workspace MV-TEWS-11 would be required for the open-cut crossing of Pilchuck Creek. The proposed loop would be installed in the trench of the 26-inch-diameter pipeline after it is removed. This construction technique requires that workspace MV-TEWS-11 be located in the river for use during removal of the 26-inch-diameter pipeline and installation of the 36-inch-diameter loop. Spoil would be stored in the creek downstream (west) of the proposed 36-inch-diameter loop. It would be stacked in separate piles with gaps in between to allow the water to flow freely through so as not to create a dam. The working side would be east of the proposed 36-inch-diameter loop. Precautions would be taken to protect the 30-inch-diameter pipeline.	Approved.
1428.60	MV-8	PEM/PSS	MV-TEWS-11 MV-TEWS-12	Workspaces MV-TEWS-11 and MV-TEWS-12 would be required for staging and for the open-cut crossing of Pilchuck Creek and for steep slope construction on the south side of the creek. Workspace MV-TEWS-11 would be required to descend the steep slope to access the creek crossing and cannot be adjusted to avoid impacts on this wetland. Workspace MV-TEWS-12 would be necessary for staging for the creek crossing as well as the steep slope. Wetland MV-8 is a disturbed emergent pasture and is expected to be dry during the late spring and summer construction window.	Approved.
1422.96 1422.88	MV-17 MV-18	PEM	MV-TEWS-45 MV-TEWS-47	Workspaces MV-TEWS-45 and MV-TEWS-47 would be required for the pullback for the South Fork Stillaguamish River HDD. Wetlands MV-17 and MV-18 are low quality, farmed wetlands; therefore, impacts on these wetlands associated with the pullback activities would be negligible and short term.	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1420.64	MV-28	PEM/PSS	MV-TEWS-60	Workspace MV-TEWS-60 would be required for the open-cut crossing of Burns Road, a private drive, and for egress/ingress. The configuration of the wetland as well as the construction right-of-way prevents locating this workspace outside the wetland.	Approved.
1419.33	MV-32A,B	PSS/PEM/ PFO	MV-TEWS-67 MV-TEWS-73	Workspace MV-TEWS-67 would be necessary for the crossover at MP 1419.31 that was located at this point to minimize impacts on landowners. Locating the crossover farther south, which would move the workspace out of the wetland, would require Northwest to acquire additional permanent easement from these landowners (e.g., Crowell and Lewis) that would further encumber these properties. Workspace MV-TEWS-73 would be located in wetland MV-32B because the alignment of the construction right-of-way runs parallel to 156th Avenue NE. The workspace would be required to maintain residential access.	Additional justification needed. The WDOE commented that the crossover should be relocated south, outside of the wetland, in accordance with WDOE policy on avoidance of wetland impacts.
1416.51	MV-41	PAB/PEM/ PSS/PFO	MV-TEWS-84	Workspace MV-TEWS-84 would be necessary for the open-cut crossing of 120th Street (Beechcraft Drive) and for egress/ingress. The expected high groundwater table and saturated and unconsolidated materials, as well as the 5-foot loop burial depth at the road crossing, require this workspace to be located in the wetland. The soil and groundwater conditions create the potential for the trench to become excessively wide, and the saturated spoil materials would require additional area for storage because they typically spread out when stacked.	Approved.
1412.12	MV-55	PEM/R/PFO/ PAB	MV-TEWS-121	Workspace MV-TEWS-121 would be required for the crossover and cannot be moved outside the wetland because the crossover is based on the location of the ending point for the Machias Replacement Project Segment E.	Approved.
1411.35	MV-61	PFO	MV-TEWS-129	Workspace MV-TEWS-129 would be required for the bore of Highway 92 and cannot be adjusted to avoid the wetland because of the required area to construct the bore pit.	Approved.
1411.06	MV-62	R	MV-TEWS-139	Workspace MV-TEWS-139 would be required for the flumed crossing of Little Pilchuck Creek. A crossover was included in the crossing design to avoid disturbing several large overflow culverts that are installed in the elevated road fill of the private drive located north of the creek crossing at MP 1411.10. Disturbing the culverts would restrict access to several residences during construction. The workspace would be required to ensure that there is adequate construction space to properly install the flume and to provide adequate space in the event the trench becomes excessively wide during trenching operations.	Additional justification needed. The WDOE commented that temporary alternative access should be provided to the residences to avoid disturbance to this wetland in accordance with WDOE policy on avoidance of wetland impacts.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1391.40 1391.31	SN-18 and SN-20	PEM/PSS/ PFO	SN-TEWS-17 SN-TEWS-19	Workspaces SN-TEWS-17 and SN-TEWS-19 would be required for the road bore of Woodinville Duvall Road NE. Workspace SN-TEWS-17 was expanded for parking/staging because the area would be primarily located in scrub-shrub vegetation and would minimize disturbance to residential tree screens. Impacts on wetland SN-18 would be temporary and short term, lasting two to three growing seasons, as shrubs would quickly revegetate from existing root systems because grading in the wetland should not be required. The location of SN-TEWS-19 was chosen to minimize impacts on conifers.	Approved.
1383.66	SN-42	PSS/PFO/ PEM/POW	SN-TEWS-65	Workspace SN-TEWS-65 would be required for staging during the crossing (push-pull) of wetland SN-42 (Evans Creek). The workspace would be located primarily in an upland lawn. However, to access the construction right-of-way, a portion of the workspace must be located in the wetland. This wetland is an extensive, saturated/open water wetland system, and the configuration of the wetland and construction right-of-way prohibits locating this workspace 50 feet from the wetland.	Approved.
1328.94 1328.65 1328.30	FL-16 FL-18 FL-19	PEM	FL-TEWS-34 FL-TEWS-35	The existing 26-inch-diameter pipeline throughout this agricultural wetland is shallow and cannot be worked over during construction to ensure its integrity. Workspaces FL-TEWS-34 and FL-TEWS-35 would be required because the existing right-of-way cannot be used by heavy equipment. Impacts on this wetland would be insignificant because the farmed wetland is cultivated annually.	Approved.
1324.29	FL-34 FL-35A,B	PFO/R	FL-TEWS-58 FL-TEWS-59	Workspaces FL-TEWS-58 and FL-TEWS-59 would be required for the open-cut crossing of the Nisqually River. At this crossing, the existing 30-inch-diameter pipeline is offset 50 feet to the east of the existing 26-inch-diameter pipeline, and the proposed 36-inch-diameter loop would be offset 35 feet to the east of the 30-inch-diameter pipeline. The offsets would be necessary to ensure that the existing pipelines are not destabilized during excavation in the stream. These workspaces would be used as the working side of the right-of-way so that heavy equipment does not work over the existing pipelines in the river.	Approved.
1323.85	FL-37	Centralia Canal	FL-TEWS-62	This workspace would be required to install the span across this diversion canal.	Approved.
1289.35	CS-1A,B,D,E	PEM	C-TEWS-4 C-TEWS-5 C-TEWS-6 C-TEWS-7	Workspaces C-TEWS-4, C-TEWS-5, C-TEWS-6, and C-TEWS-7 would be required to support design changes needed to comply with county requirements. No other practical upland space is available to site these workspaces.	Approved.

TABLE N-3 (cont'd)

Variances Requested for Temporary Extra Workspaces (TEWS) Located Within Wetlands or Waterbodies

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status

[a] Wetland types according to Cowardin et al. (1979):
PFO = palustrine forested
PSS = palustrine scrub-shrub
PEM = palustrine emergent
POW = palustrine open water
PAB = palustrine aquatic bed
R = riverine

TABLE N-4

Variances Requested for a Wet Open-Cut Crossing of the North Forth Nooksack River, North Fork Stillaguamish River, and South Fork Stillaguamish River

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
Variances Requested for Temporary Extra Workspaces (TEWS) Located Less Than 50 feet From Wetlands or Waterbodies					
1424.32 1424.26	MV-13B MV-14	PSS/R	MV-TEWS-39.6A	Workspace MV-TEWS-39.6A would be necessary for staging for a wet open-cut crossing of the North Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. Placement of the workspace on the north side of the waterbody would accommodate pipe stringing. It is not possible to set the workspace 50 feet back from the wetland or from the waterbody because of the proximity of wetlands MV-13B and MV-14 (the waterbody). The workspace would also be required to store the large volume of spoil that is expected at this crossing because of the elevated banks above the waterbody.	Approved only if the HDD is unsuccessful.
1423.84	MV-15	R	MV-TEWS-40.4A MV-TEWS-40.5A	Workspaces MV-TEWS-40.4A and MV-TEWS-40.5A would be necessary for staging for a wet open-cut crossing of the South Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. Workspace MV-TEWS-40.4A would be primarily located in a previously cleared area that is currently in hay and Christmas tree production. However, based on the location of wetland MV-15 and the alignment of the proposed loop, it would not be possible to set these workspaces 50 feet back from the waterbody and associated wetlands and complete the crossing. These workspaces would also be required in the event a dragline must be staged to assist in construction of the crossing because of the waterbody's depth at the time of the crossing or other site-specific conditions and the potential need to set sheet piling in order to stabilize the excavated trench. These workspaces were designed to store the volume of fill that would be excavated and graded along the right-of-way because of the elevated banks above the waterbody.	Approved only if the HDD is unsuccessful.
Variances Requested for TEWS Located Within Wetlands or Waterbodies					
1468.68	S-68	R	S-TEWS-133A	Workspace S-TEWS-133A would be required for a flumed crossing of Jim Creek in the event the proposed HDD crossing is unsuccessful. The trench is expected to be excessively wide due to the high groundwater table, saturated and unconsolidated soils, and steeply incised conditions at the crossing location. The workspace would also be necessary to contain the saturated spoil material because these materials generally spread out when they are stacked.	Approved only if the HDD is unsuccessful.

TABLE N-4 (cont'd)

Variances Requested for a Wet Open-Cut Crossing of the North Forth Nooksack River, North Fork Stillaguamish River, and South Fork Stillaguamish River

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1468.20	S-69 S-70	R	S-TEWS-136A	Workspace S-TEWS-136A would be required for a wet open-cut crossing of the North Fork Nooksack River in the event the proposed HDD crossing is unsuccessful. At the crossing location, the proposed 36-inch-diameter loop would be offset 60 feet east of the 30-inch-diameter pipeline. The 60-foot offset is necessary to ensure that the existing pipelines would not be destabilized during excavation in the waterbody. The workspace would be used as the working side of the right-of-way so that heavy equipment would not have to work over the existing pipelines in the waterbody. The workspace would also be required to temporarily store trench spoil (stacked in separate piles with gaps in between to allow for water passage) within the waterbody as well as allow adequate area to push the spoil back into the trench (backfill) after the pipeline is installed.	Approved only if the HDD is unsuccessful.
1424.37 1424.32	MV-13A MV-13B	PSS	MV-TEWS-39.3A MV-TEWS-39.4A MV-TEWS-39.5A	Workspaces MV-TEWS-39.3A, MV-TEWS-39.4A, and MV-TEWS-39.5A would be necessary for staging and pipe string layout for a wet open-cut crossing of the North Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. The pipe string would be laid out on the north side of the river and sufficiently sized upland areas would not be available to avoid placement of these workspaces in wetlands MV-13A and MV-13B. Also, the presence of steep slopes north of wetland MV-13A prevent locating workspace MV-TEWS-39.3A 50 feet from the wetland. Furthermore, the loop would cross an abandoned railroad grade that would require excavation through a significant volume of elevated fill. The trench is expected to become excessively wide due to the high groundwater table, saturated and unconsolidated soils, and steeply incised conditions at the crossing location. The workspace would also be necessary to contain the saturated spoil material because these materials generally spread out when they are stacked. Workspaces MV-TEWS-39.4A and MV-TEWS-39.5 would be required in the event a dragline must be staged to assist in construction of the crossing because of the waterbody's depth at the time of the crossing or other site-specific conditions and the potential need to set sheet piling in order to stabilize the excavated trench. These workspaces were designed to store the volume of fill that would be excavated and graded along the right-of-way because of the elevated banks above the waterbody.	Approved only if the HDD is unsuccessful.
1424.26	MV-14	R	MV-TEWS-39.7A	Workspace MV-TEWS-39.7A would be required for a wet open-cut crossing of the North Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. The workspace would be used as the working side of the right-of-way so that heavy equipment would not work over the existing pipelines in the waterbody. The workspace would also be required to temporarily store trench spoil (stacked in separate piles with gaps in between to allow for water passage) within the waterbody as well as allow adequate area to push the spoil back into the trench (backfill) after the pipeline is installed.	Approved only if the HDD is unsuccessful.

TABLE N-4 (cont'd)

Variances Requested for a Wet Open-Cut Crossing of the North Forth Nooksack River, North Fork Stillaguamish River, and South Fork Stillaguamish River

Milepost	Wetland	Cowardin Type [a]	Temporary Extra Workspace ID	Variance Rationale	Approval Status
1424.20	MV-13C	PSS	MV-TEWS-39.8A MV-TEWS-39.9A	Workspaces MV-TEWS-39.8A and MV-TEWS-39.9A would be required for staging of a wet open-cut crossing of the North Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. Upland areas are not available in the vicinity of the crossing to avoid placement of these workspaces in wetland MV-13C. The trench is expected to become excessively wide due to the high groundwater table and saturated and unconsolidated soils at the crossing location. The workspaces would be necessary to contain the saturated spoil material because these materials generally spread out when they are stacked. These workspaces would also be required in the event a dragline must be staged to assist in construction of the crossing because of the waterbody's depth at the time of the crossing or other site-specific conditions and the potential need to set sheet piling in order to stabilize the excavated trench. These workspaces were designed to store the volume of fill that would be excavated and graded along the right-of-way because of the elevated banks above the waterbody.	Approved only if the HDD is unsuccessful.
1423.84	MV-15	R	MV-TEWS-40.6A	Workspace MV-TEWS-40.6A would be required for a wet open-cut crossing of the South Fork Stillaguamish River in the event the proposed HDD crossing is unsuccessful. The workspace would ensure that the existing pipelines are not destabilized during excavation in the waterbody. The workspace would also be used as the working side of the right-of-way so that heavy equipment would not work over the existing pipelines in the waterbody. In addition, the workspace would be required to temporarily store trench spoil (stacked in separate piles with gaps in between to allow for water passage) within the waterbody during the crossing as well as allow adequate area to push the spoil back into the trench (backfill) after the pipeline is installed.	Approved only if the HDD is unsuccessful.
1423.46	MV-16	PEM/R	MV-TEWS-40.11A	Workspace MV-TEWS-40.11A would be required to cross wetland MV-16 in the event the proposed HDD crossing of the South Fork Stillaguamish River is unsuccessful. The trench is expected to become excessively wide due to the high groundwater table and saturated and unconsolidated soils at the crossing location. The workspace would be necessary to contain the saturated spoil material because these materials generally spread out when they are stacked.	Approved only if the HDD is unsuccessful.

[a] Wetland types according to Cowardin et al. (1979):
PFO = palustrine forested
PSS = palustrine scrub-shrub
PEM = palustrine emergent
POW = palustrine open water
PAB = palustrine aquatic bed
R = riverine

APPENDIX O

FISH UTILIZATION AND ESSENTIAL FISH HABITAT IN WATERBODIES CROSSED BY THE CAPACITY REPLACEMENT PROJECT

TABLE O-1

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
Sumas Loop									
	Wetland Ditch	S-1.1A	1484.4	NA					
	Wetland Ditch	S-1.1B	1484.4	NA					
	Wetland Ditch	S-2	1484.0	NA					
	Wetland Ditch	S-2	1483.9	NA					
	Wetland Ditch	S-2	1483.9	NA					
	Wetland Ditch	S-2	1483.9	NA					
	Upland Ditch	S-3A	1483.6	NA					
	Upland Ditch	S-3B	1483.4	NA					
	Upland Ditch	S-3C	1483.3	NA					
	Saar Creek	S-4A	1483.1	1	None	Chinook-D Chum-D Coho-R Sockeye-D Steelhead-D	Cutthroat Rainbow	Coho	Migration Spawning Rearing
	Upland Ditch	S-5A	1483.0	NA					
	Upland Ditch	S-5B	1483.0	NA					
	Saar Creek	S-4B	1482.8	1	None	Chinook-D Chum-D Coho-S Sockeye-D Steelhead-D	Cutthroat Rainbow	Coho	Migration Spawning Rearing
	Tributary to Lake Creek	S-7	1481.4	5					
	Tributary to Lake Creek	S-9	1481.0	4					
	Wetland Ditch	S-10	1480.9	NA					
	Tributary to Kinney Creek	S-14	1480.0	5					
	Tributary to Kinney Creek	S-16	1480.0	5					
	Kinney Creek	S-21	1479.1	3	None	Coho-Pr Steelhead-Pr	Cutthroat Rainbow	Coho	Unknown
	Breckenridge Creek	S-22	1478.9	3	None	Chinook-D Coho-S Steelhead-Pr Cutthroat-S	Cutthroat Rainbow	Coho	Migration Spawning Rearing
	Upland Ditch	S-22.1A	1478.2	NA					
	Upland Ditch	S-22.1B	1478.2	NA					
	Swift Creek	S-23	1477.6	3	None	Steelhead-D	Cutthroat Rainbow	Unknown	Unknown
	Unnamed Tributary	S-25	1477.1	3 [e]	None	Unknown	Cutthroat	Unknown	Unknown
	Unnamed Tributary	S-26.1A	1477.0	3 [e]	None	Unknown	Cutthroat	Unknown	Unknown
	Unnamed Tributary	S-26.1B	1476.9	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Sumas River	S-27	1476.8	3	None	Coho-D	Unknown	Coho	Unknown
	Pond Outlet	S-27	1476.8	3	None	Unknown	Unknown	Unknown	Unknown
	Tributary to Sumas River	S-29	1476.4	5					
	Upland Ditch	S-29.1	1476.3	NA					
	Upland Ditch	S-29.2	1476.3	NA					
	Tributary to Sumas River	S-30	1476.2	3	None	Unknown	Cutthroat Rainbow	Unknown	Unknown
	Tributary to Sumas River	S-31A, B	1476.1	3	None	Unknown	Unknown	Unknown	Unknown
	Dale Creek	S-32	1475.9	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Tributary to Sumas River	S-35	1475.7	3 [e]	None	Unknown	Cutthroat	Unknown	Unknown
	Tributary to Sumas River	S-38	1475.4	5					
	Unnamed Tributary	S-39	1475.2	5					
	Unnamed Tributary	S-43	1474.6	5					
	Unnamed Tributary	S-44	1474.5	4					
	Tributary to Sumas River	S-47	1473.7	3	None	Coho-Pr	Unknown	Coho	Unknown
	Tributary to Smith Creek	S-48	1473.3	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Upland Ditch	S-49.1	1473.1	NA					
	Upland Ditch	S-51	1472.7	NA					
	Unnamed Tributary	S-52	1472.6	5					
	Wetland Ditch	S-53	1472.6	NA					
	Upland Ditch	S-53.1	1472.5	NA					
	Smith Creek	S-54	1472.2	2	Bull trout P-CH Chinook F-CH	Chinook-Pr Coho-D Steelhead-S Cutthroat-S	Cutthroat Rainbow	Chinook Coho	Unknown
	Tributary to Macaulay Creek	S-55	1472.0	3	Chinook F-CH	Steelhead-S	Cutthroat	Unknown	Unknown
	Tributary to Macaulay Creek	S-56	1471.6	3 [e]	None	Unknown	Cutthroat	Unknown	Unknown
	Upland Ditch	S-56.1	1471.5	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Macaulay Creek	S-57	1471.0	3	Chinook F-CH	Chinook-D Coho-R	Cutthroat	Chinook Coho	Migration Rearing
	Tributary to Mitchell Creek	S-57.1	1470.9	3	Chinook F-CH	Chinook-D Coho-S	Cutthroat	Chinook Coho	Migration Spawning
	Mitchell Creek (ditch)	S-59	1470.8	3	Chinook F-CH	Chinook-D Coho-S Steelhead-S	Cutthroat	Chinook Coho	Migration Spawning

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Mitchell Creek	S-60	1470.1	3	Chinook F-CH	Coho-S	Unknown	Coho	Migration Spawning
	Tributary to Mitchell Creek	S-62	1469.8	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Ditch and Unnamed Tributary	S-64	1469.2 1469.1	5					
	Tributary to Jim Creek	S-66	1468.8	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Tributary to Jim Creek	S-67A	1468.8	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Tributary to Jim Creek	S-67B	1468.8	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Jim Creek	S-68	1468.7	3	Chinook F-CH	Chum-D Coho-D	Unknown	Coho	Unknown
	Tributary to North Fork Nooksack River	S-69	1468.4	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	North Fork Nooksack River	S-70	1468.2	1	Bull trout P-CH Chinook F-CH	Bull trout-R Chinook-S Chum-D Coho-R Pink-S Sockeye-R Steelhead-S Cutthroat-S	Lake Trout Whitefish	Chinook Coho Pink	Migration Spawning Rearing
	Tributary to South Fork Nooksack River	S-73	1467.4	3	Chinook F-CH	Chum-D Coho-S Sockeye-D Steelhead-D Cutthroat-S	Cutthroat Rainbow	Coho	Unknown
	Tributary to South Fork Nooksack River	S-74	1467.3	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Tributary to South Fork Nooksack River	S-74	1467.2	5					
	Tributary to South Fork Nooksack River	S-75	1467.0	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Tributary to South Fork Nooksack River	S-76	1466.8	3	Chinook F-CH	Chum-D Coho-Pr	Cutthroat	Coho	Unknown
	Tributary to South Fork Nooksack River	S-76	1466.7	3 [e]	None	Unknown	Cutthroat	Unknown	Unknown
	Tributary to Black Slough	S-78	1465.8	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Wetland Ditch	S-80A	1465.5	NA					
	Wetland Ditch	S-80B	1465.5	NA					

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Black Slough	S-82	1465.0	3	Chinook F-CH	Coho-D	Unknown	Coho	Unknown
	Wetland Ditch	S-82	1465.0	NA					
	Wetland Ditch	S-82	1464.9	NA					
	Wetland Ditch	S-82	1464.7	NA	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Unnamed Tributary	S-83	1464.7	3 [e]	None	Unknown	Unknown	Unknown	Unknown
	Tinling Creek	S-84	1464.6	3	Chinook F-CH	Chum-S Coho-S	Cutthroat	Coho	Unknown
	Wetland Ditch	S-85	1464.5	NA					
	Unnamed Tributary	S-85	1464.2	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Wetland Ditch	S-86A	1463.8	NA					
	Wetland Ditch	S-86B	1463.7	NA					
	Wetland Ditch	S-87	1463.5	NA					
	Tributary to Black Slough	S-88	1463.3	3 [e]	None	Coho-D	Cutthroat	Coho	Unknown
	Wetland Ditch	S-89A	1463.0	NA	Chinook F-CH	Coho-D	Unknown	Coho	Unknown
	Wetland Ditch	S-89B	1463.0	NA					
	Tributary to South Fork Nooksack River	S-91	1461.9	3	Chinook F-CH	Chinook-Pr Coho-Pr	Unknown	Chinook Coho	Unknown
Mount Vernon Loop									
	Pilchuck Creek	MV-7	1428.6	1	Bull trout Chinook F-CH	Bull trout-Pr Chinook-S Chum-R Coho-R Pink-S Steelhead-S Cutthroat-S	Cutthroat	Chinook Coho Pink	Migration Spawning Rearing
	Tributary to Pilchuck Creek (ditch)	MV-8	1428.6	5					
	Tributary to Pilchuck Creek	MV-8.1	1428.5	5					
	Armstrong Creek	MV-11	1425.6	2	Bull trout Chinook F-CH	Bull trout-Pr Chinook-Po Chum-Po Coho-S Pink-S Steelhead-Pr Cutthroat-S	Cutthroat	Chinook Coho Pink	Migration Spawning Rearing

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	North Fork Stillaguamish River	MV-14	1424.3	1	Bull trout P-CH Chinook F-CH	Bull trout-R Chinook-S Chum-R Coho-R Pink-S Steelhead-S Cutthroat-S	Cutthroat Rainbow Whitefish	Chinook Coho Pink	Migration Spawning Rearing
	South Fork Stillaguamish River	MV-15	1423.8	1	Bull trout P-CH Chinook F-CH	Bull trout-R Chinook-S Chum-S Coho-R Pink-S Steelhead-S Cutthroat-S	Cutthroat Rainbow Whitefish	Chinook Coho Pink	Migration Spawning Rearing
	Eagle Creek	MV-16	1423.5	3	Chinook F-CH	Chum-D Coho-D Cutthroat-Pr	Unknown	Coho	Unknown
	Wetland Ditch	MV-17	1423.0	NA					
	Wetland Ditch	MV-18	1422.8	NA					
	Tributary to South Fork Stillaguamish River	MV-20	1422.2	5					
	Tributary to South Fork Stillaguamish River	MV-23	1421.9	5					
	Wetland Ditch	MV-24	1421.9	NA					
	Tributary to South Fork Stillaguamish River	MV-27	1421.3	3	Chinook F-CH	Coho-S Cutthroat-D	Unknown	Coho	Migration Spawning
	Olson Lake	MV-32A,B	1419.3	2	Chinook F-CH	Coho-Pr	Unknown	Coho	Unknown
	Tributary to Star Creek (ditch)	MV-44	1416.0	5					
	Upland Ditch	MV-45	1415.9	NA					
	Upland ditch	MV-47A	1415.5	NA					
	Upland ditch	MV-47B	1415.5	NA					
	Star Creek	MV-49.1	1415.3	3	Chinook F-CH	Coho-S	Cutthroat	Coho	Migration Spawning
	Tributary to Little Pilchuck Creek	MV-50	1414.5	5					
	Upland ditch	MV-50.1	1414.1	NA					
	Upland ditch	MV-51	1414.0	NA					
	Upland ditch	MV-53A	1413.7	NA					
	Upland ditch	MV-53B	1413.7	NA					
	Upland ditch	MV-54	1413.1	NA					

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Little Pilchuck Creek	MV-55	1412.1	3	Chinook F-CH	Coho-S	Cutthroat	Coho	Migration Spawning
	Tributary to Little Pilchuck Creek	MV-57	1411.9	5					
	Upland ditch	MV-59	1411.8	NA					
	Upland ditch	MV-59.1	1411.6	NA					
	Little Pilchuck Creek	MV-62	1411.1	1	Chinook F-CH	Coho-S Steelhead-S Cutthroat-S	Cutthroat	Coho	Migration Spawning
	Little Pilchuck Creek	MV-63	1410.5	1	Bull trout Chinook F-CH	Bull trout-R Coho-S Steelhead-S Cutthroat-S	Cutthroat	Coho	Migration Spawning
	Upland Ditch	MV-64	1410.3	NA					
	Catherine Creek	MV-66	1409.6	1	Bull trout Chinook F-CH	Bull trout-R Coho-S Steelhead-S Cutthroat-S	Cutthroat	Coho	Migration Spawning
Snohomish Loop									
	Tributary to Paradise Lake/Bear Creek	SN-2	1393.8	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Upland Ditch	SN-2.1	1393.7	NA					
	Upland Ditch	SN-3.2A	1393.5	NA					
	Upland Ditch	SN-3.2B	1393.5	NA					
	Tributary to Paradise Lake/Bear Creek	SN-4	1393.3	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Paradise Lake/Bear Creek	SN-6	1393.1	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Paradise Lake/Bear Creek	SN-6	1393.1	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Paradise Lake/Bear Creek	SN-2	1393.1	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Paradise Lake/Bear Creek	SN-7	1393.0	3	Chinook F-CH	Coho-S	Unknown	Coho	Migration Spawning
	Tributary to Paradise Lake/Bear Creek	SN-21	1391.2	3	Chinook F-CH	Coho-S	Unknown	Coho	Migration Spawning
	Struve Creek	SN-22	1390.2	3	Chinook F-CH	Coho-R	Cutthroat	Coho	Migration Rearing
	Colin Creek	SN-24	1389.4	3	Chinook F-CH	Coho-S	Cutthroat	Coho	Migration Spawning

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Seidel Creek	SN-28A, B	1388.6	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Seidel Creek	SN-29	1388.5	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
	Tributary to Bear Creek	SN-32	1387.2	5					
	Tributary to Evans Creek	SN-37	1385.8	4					
	Tributary to Evans Creek	SN-38	1385.8	4					
	Tributary to Evans Creek	SN-39.3	1385.5	5					
	Upland Ditch	SN-40.2	1385.0	NA					
	Evans Creek	SN-42	1383.7	3	Chinook F-CH	Coho-S	Cutthroat	Coho	Migration Spawning
	Tributary to Evans Creek	SN-43	1383.4	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown
Fort Lewis Loop									
	Muck Creek	FL-12	1332.4	2	Chinook F-CH	Chum-S Coho-S Steelhead-D Cutthroat-S	Cutthroat	Coho	Migration Spawning
	South Fork Creek	FL-13	1332.1	2	Chinook F-CH	Chum-D Coho-D Steelhead-Pr Cutthroat-S	Cutthroat	Coho	Unknown
	Lacamas Creek	FL-17	1328.7	3	Chinook F-CH	Chum-Pr Coho-S Steelhead-Pr Cutthroat-S	Cutthroat	Coho	Migration Spawning
	Murray Creek	FL-23	1327.9	3	Chinook F-CH	Chum-Po Coho-Po Steelhead-Po Cutthroat-S	Cutthroat	Coho	Unknown
	Nisqually River	FL-35A,B	1324.3	1	Bull trout P-CH Chinook F-CH	Bull trout-Pr Chinook-S Chum-S Coho-S Pink-S Sockeye-D Steelhead-S Cutthroat-S	Cutthroat Whitefish	Chinook Coho Pink	Migration Spawning
	Centralia Canal	FL-37	1323.9	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown

TABLE O-1 (cont'd)

Fish Utilization and Essential Fish Habitat (EFH) in Waterbodies Crossed by the Capacity Replacement Project

Facility	Feature	Waterbody Identification	Milepost	WDNR Stream Type [a]	ESA Species Present [b]	Priority Anadromous Species Present [b, c]	Priority Resident Species Present [d]	EFH Species Present [b]	EFH Component Present [b]
	Tributary to Yelm Creek (ditch)	FL-43	1320.7	5					
	Upland Ditch	FL-44.1A	1320.5	NA					
	Upland Ditch	FL-44.1B	1320.5	NA					
	Tributary to Yelm Creek	FL-45	1320.4	5					
	Upland Ditch	FL-45.1B	1319.8	NA					
	Upland Ditch	FL-46	1319.6	NA					
	Upland Ditch	FL-46.1	1319.1	NA					
	Upland Ditch	FL-47.1A	1318.8	NA					
	Upland Ditch	FL-47.1B	1318.8	NA					
Portland Lateral Take-off									
	Tributary to East Fork Lewis River (ditch)	AF-1	1232.5	3	Chinook F-CH	Unknown	Unknown	Unknown	Unknown

[a] Washington State Department of Natural Resources (WDNR) Stream Types (Washington Forest Practices Board, 2000):

Type 1 Water - includes all waters, within their ordinary high-water mark, as inventoried a "shorelines of the state" under Revised Code of Washington (RCW) Chapter 90.58 and the rules promulgated pursuant to RCW Chapter 90.58, but not including those waters' associated wetlands as defined in RCW Chapter 90.58.

Type 2 Water - Includes segments of natural waters that are not classified as Type 1 Water and have a high fish, wildlife, or human use.

Type 3 Water - Includes segments of natural waters that are not classified as Type 1 or 2 Waters and have a moderate to slight fish, wildlife, or human use.

Type 4 Water - Includes segments of natural waters within the bankfull width of defined channels that are not classified as Type 1, 2, or 3 Waters and are perennial waters of nonfish-bearing streams.

Type 5 Water - Includes segments of natural waters within the bankfull width of defined channels that are not classified as Type 1, 2, 3, or 4 Waters and are seasonal nonfish-bearing streams.

[b] Endangered Species Act (ESA) species, priority anadromous species, and EFH components were identified from the SalmonScape component of the Salmon and Steelhead Habitat Inventory and Assessment Program (Washington Department of Fish and Wildlife (WDFW) and Northwest Indian Fisheries Commission (NWIFC), 2004). P-CH = proposed critical habitat; F-CH = former critical habitat.

[c] Anadromous species presence codes are (WDFW and NWIFC, 2004): S = spawning; R = rearing; D = documented occurrence; Pr = presumed occurrence; Po = potential occurrence. Coastal cutthroat trout spawning was identified from WDFW, 2000.

[d] Resident species were identified from the Priority Habitat and Species Database (WDFW, 2003a).

[e] No information is available in the SalmonScape component of the Salmon and Steelhead Habitat Inventory and Assessment Program (WDFW) and NWIFC for these waterbodies. The information provided was taken from the WDFW's field notes (Buchanan, 2005).

NA = Not applicable. The WDNR does not type wetland and upland ditches.

APPENDIX P

RESIDENCES AND OTHER STUCTURES WITHIN 50 FEET OF THE CONSTRUCTION WORK AREA FOR THE CAPACITY REPLACEMENT PROJECT

TABLE P-1

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
Sumas Loop						
	1478.98	Residence		9.45		44.45
	1478.95	Residence		43.96		98.96
	1478.84	Residence		55.36		110.36
	1478.64	Residence		55.23		110.23
	1478.40	Residence	0.15		40.15	
	1478.23	Residence	23.96		43.96	
	1478.18	Residence	32.29		92.29	
	1478.13	Residence	13.54		73.54	
	1476.19	Residence	21.41		106.41	
	1475.81	Residence		47.92		102.92
	1475.65	Shop/Barn		0.25		50.25
	1475.58	Residence		43.31		98.31
	1473.40	Barns		5.21		25.00
	1472.26	Shop Building		29.37		74.37
	1472.10	Winery		12.59		57.59
	1472.02	Residence		5.82		30.82
	1471.66	Residence		30.16		65.16
	1471.37	Residence	5.64		65.64	
	1470.46	Residence	29.89		89.89	
	1470.41	Residence/Shops	2.44		82.44	
	1470.34	Residence	3.76		43.76	
	1470.27	Residence		41.75		106.75
	1469.98	Residence		9.95		54.95
	1469.22	Residence/Barns	27.61		137.61	
	1466.23	Residence		16.85		51.85
Mount Vernon Loop						
	1429.90	Residence		32.71		67.71
	1429.88	Residence		39.11		74.11
	1427.42	Residence	10.06		70.06	
	1427.32	Residence	43.16		103.16	
	1425.82	Hot Houses		5.63		25.63
	1424.10	Tree House/Barn		33.52		108.52
	1423.95	Residence		HDD		78.82
	1422.44	Residence		37.07		72.07
	1421.99	Residence	42.73		102.73	
	1420.67	Residence		9.10		44.10
	1418.83	Trailer/Playhouse	53.73		113.73	
	1416.08	Residence	27.32		87.32	
	1415.75	Residence	0.39		60.39	
	1414.92	Shop		45.88		100.88
	1414.86	Shop		28.65		63.65
	1414.15	Golf Course Buildings	46.58		106.58	
	1414.01	Residence/Garage		14.60		49.60

TABLE P-1 (cont'd)

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
	1413.89	Residence/Garage		7.29		42.29
	1413.83	Residence	35.94		115.94	
	1413.26	Shop		4.72		19.72
	1413.13	Residence/Garage		59.19		94.19
	1412.95	Residence/Hothouse		27.65		62.65
	1411.56	Residence		9.91		79.91
	1411.56	Residence	18.76		43.76	
	1410.80	Apartments	34.91		74.91	
	1410.62	Residence	2.19		37.19	
	1410.62	Residence		0.44		20.44
	1410.58	Residence		6.77		46.77
Snohomish Loop						
	1393.70	Residence		11.98		66.98
	1393.70	Residence	48.43		88.43	
	1393.46	Residence		44.47		95.00
	1391.73	Residence		15.39		70.39
	1391.71	Residence		7.46		47.46
	1391.62	Residence	2.45		22.45	
	1391.60	Residence	25.44		65.44	
	1391.09	Residence	10.47		50.47	
	1391.09	Residence		50.09		125.09
	1390.96	Residence		57.87		97.87
	1390.93	Residence		44.82		84.82
	1389.90	Garage and Horse Barn		4.71		59.71
	1389.73	Residence	30.80		70.80	
	1389.68	Residence		48.51		103.51
	1389.51	Residence		7.31		62.31
	1389.47	Residence	6.27		46.27	
	1389.45	Residence		9.89		49.89
	1389.57	Residence		12.02		52.02
	1389.55	Residence	4.17		44.17	
	1389.35	Residence		10.47		45.47
	1389.31	Residence		24.53		59.53
	1389.24	Residence		37.56		92.56
	1389.21	Residence		30.32		85.32
	1388.91	Residence		0.26		55.26
	1388.90	Residence		50.01		105.01
	1387.25	Residence	40.67		80.67	
	1387.22	Residence	46.68		86.68	
	1386.21	Residence		26.16		81.16
	1386.02	Green Houses	On right-of-way		On centerline	
	1385.26	Residence/Garage	19.52		59.52	
	1384.84	Residence		17.32		57.32
	1384.79	Residence		2.15		42.15
	1384.78	Pool	50.46		90.46	

TABLE P-1 (cont'd)

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
	1384.36	Residence		21.07		76.07
	1384.33	Residence	1.56		41.56	
	1384.30	Residence	17.38		57.38	
	1384.26	Residence		12.03		67.03
	1384.24	Residence	23.72		63.72	
	1384.20	Residence		38.96		93.96
	1384.17	Residence/Office		58.41		113.41
	1383.26	Residence	8.35		28.35	
	1383.23	Residence	15.39		55.39	
	1383.22	Residence	40.09		80.09	
	1383.19	Residence	8.90		48.90	
	1383.17	Residence	25.37		65.37	
	1383.15	Residence	13.35		33.35	
	1383.08	Residence	19.15		39.15	
	1383.07	Residence		53.71		93.71
	1383.06	Residence		45.97		85.97
	1383.04	Residence		50		90
	1383.03	Residence		48.17		88.17
	1383.02	Residence	23.41		43.41	
	1383.02	Residence		36.03		76.03
	1383.01	Residence		40.18		80.18
	1383.00	Residence	29.50		49.50	
	1382.99	Residence		40.35		80.35
	1382.96	Residence		20.26		60.26
	1382.95	Residence		39.56		79.56
	1382.94	Residence		43.16		83.16
	1392.94	Residence	27.06		47.06	
	1382.92	Residence		47.30		87.30
	1382.91	Residence		56.69		96.69
	1382.87	Residence	40.77		60.77	
	1382.88	Residence		13.84		53.84
	1382.87	Residence	12.38		32.38	
	1382.86	Residence		19.11		59.11
	1382.86	Residence	7.09		27.09	
	1382.85	Residence		20.11		60.11
	1382.84	Residence	19.46		39.46	
	1382.83	Residence		40.07		80.07
	1382.82	Residence	24.05		44.05	
	1382.82	Residence		39.79		79.79
	1382.81	Residence	27.54		47.54	
	1382.81	Residence		36.42		76.42
	1382.79	Residence	37.41		57.41	
	1382.79	Residence		39.16		79.16
	1382.78	Residence	45.55		65.55	
	1382.78	Residence		34.42		74.42

TABLE P-1 (cont'd)

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
	1382.76	Residence		24.05		64.05
	1382.76	Residence	0		20	
	1382.75	Residence	49.94		69.94	
	1382.72	Residence		16.31		56.31
	1382.72	Residence	0.91		20.91	
	1382.72	Residence		37.22		77.22
	1382.70	Residence		32.09		72.09
	1382.69	Residence		41.36		81.36
	1382.69	Residence	13.18		33.18	
	1382.68	Residence	15.17		35.17	
	1382.66	Residence	10.23		30.23	
	1382.66	Residence		42.71		82.71
	1382.64	Residence	4.81		24.81	
	1382.64	Residence		33.48		73.48
	1382.63	Residence	0.39		20.39	
	1382.63	Residence		34.53		74.53
	1382.61	Residence	10.62		30.62	
	1382.60	Residence		35.42		75.42
	1382.59	Residence	21.91		41.91	
	1382.57	Residence	18.61		38.61	
	1382.58	Residence		25.86		65.86
	1382.56	Residence	11.88		31.88	
	1382.56	Residence		25.86		65.86
	1382.53	Residence	0		20	
	1382.52	Residence		17.18		57.18
	1382.51	Residence	3.79		23.79	
	1382.50	Residence		42.49		82.49
	1382.49	Residence		43.85		83.85
	1382.49	Residence	4.80		24.80	
	1382.48	Residence	9.10		29.10	
	1382.47	Residence		51.80		91.80
	1382.47	Residence	14.66		34.66	
	1382.46	Residence		38.07		78.07
	1382.45	Residence	3.79		23.79	
	1382.44	Residence		44.47		84.47
	1382.44	Residence	8.59		28.59	
	1382.43	Residence		30.33		70.33
	1382.42	Residence	0		20	
	1382.41	Residence	23.89		43.89	
	1382.41	Residence		30.33		70.33
	1382.39	Residence	55.23		75.23	
	1382.34	Residence	51.41		71.41	
	1382.33	Residence	36.64		56.64	
	1382.30	Residence	9.23		29.23	
	1382.28	Residence	35.63		55.63	

TABLE P-1 (cont'd)

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
	1382.26	Residence	41.43		61.43	
Fort Lewis Loop						
	1337.55	Residence		5.44		40.44
	1337.52	Residence		31.96		66.96
	1337.23	Residence/Sheds	23.54		83.54	
	1337.14	Residence	13.44		73.44	
	1337.15	Shop		9.58		24.58
	1337.12	Residence		2.21		17.21
	1336.68	Residence		37.02		52.02
	1336.67	Residence		28.65		43.65
	1336.65	Residence		24.49		39.49
	1336.65	Residence	32.82		92.82	
	1336.63	Residence		33.58		48.58
	1336.62	Residence	28.03		88.03	
	1336.61	Residence		30.20		50.20
	1336.59	Residence		22.65		42.65
	1336.58	Residence	35.02		90.02	
	1336.55	Residence	21.15		79.15	
	1336.54	Residence		55.57		72.57
	1336.53	Residence		33.35		50.35
	1336.51	Residence		13.75		30.75
	1336.50	Residence		27.50		44.50
	1336.48	Residence	57.53		115.53	
	1336.48	Residence		41.89		58.89
	1336.47	Residence		58.27		75.27
	1336.46	Residence	53.22		111.22	
	1336.44	Residence	9.69		26.69	
	1336.41	Residence	38.76		98.76	
	1336.38	Residence	25.95		85.95	
	1336.33	Residence	14.03		74.03	
	1336.32	Residence		0.00		15.00
	1336.31	Residence	16.30		76.30	
	2336.28	Residence		43.37		58.37
	1336.01	Residence		7.81		22.81
	1336.00	Residence		0.34		15.34
	1335.67	Residence	14.68		74.68	
	1335.65	Residence/Sheds		8.96		23.96
	1335.61	Residence	13.76		73.76	
	1335.57	Residence/Sheds	17.96		77.96	
	1335.54	Trailer	26.36		86.36	
	1335.51	Trailer		41.49		58.49
	1335.41	Residence	56.90		116.90	
	1335.30	Highway Department Office	52.49		72.49	
	1329.70	Residence/Barn		0		25
	1329.19	Farm	14.37		74.37	

TABLE P-1 (cont'd)

Residences and Other Structures Within 50 Feet of the Construction Work Area for the Capacity Replacement Project

Facility	Milepost	Residence/Business (Permanent Structure)	Distance from Edge of Construction Right-of-Way or Additional Temporary Extra Workspace (feet)		Distance from Loop Centerline (feet)	
			West	East	West	East
	1327.37	Shop		On right-of-way		N/A
	1325.09	Residence	24.35		84.35	
	1325.07	Residence		27.29		62.29
	1323.74	Residence	20.26		80.26	
	1322.99	Residence		0.08		50.08
	1322.74	Residence		20.52		80.52
	1322.71	Residence		13.44		73.44
	1322.63	Duplex		5.31		45.31
	1322.61	Apartment		44.06		104.06
	1322.32	Residence	23.67		83.67	
	1321.66	Residence	26.77		86.77	
	1321.00	Residence		36.48		71.48
	1320.56	Residence/Barn	57.55		117.55	
	1320.02	Residence	55.81		115.81	
	1319.86	Residence	31.32		91.32	
	1319.59	Residence	9.57		64.57	
	1318.95	Residence/Sheds		11.71		46.71
	1317.77	Residence	25.28		85.28	
	1316.85	Residence		26.35		75.35
	1316.36	Green Houses	42.87		102.87	
	1316.15	Barn	4.69		64.69	
	1315.93	Residence	14.22		74.22	
	1315.91	Residence/Shed		50.56		85.56
	1315.73	Residence	50.93		110.93	

APPENDIX Q

KEY OBSERVATION POINTS FOR THE VISUAL ANALYSIS ASSOCIATED WITH THE CAPACITY REPLACEMENT PROJECT

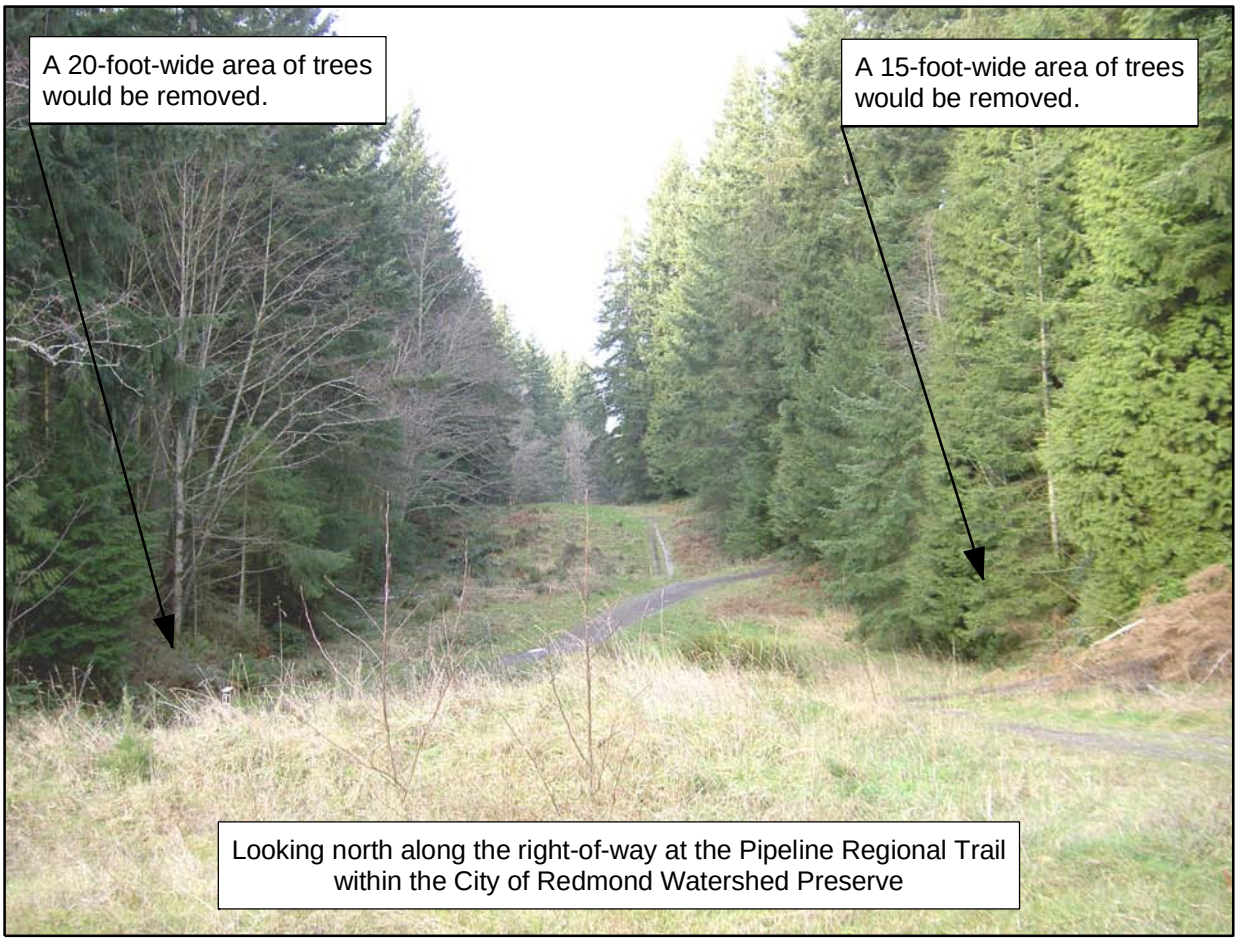


Figure Q-1
Capacity Replacement Project
Pipeline Regional Trail Key Observation Point

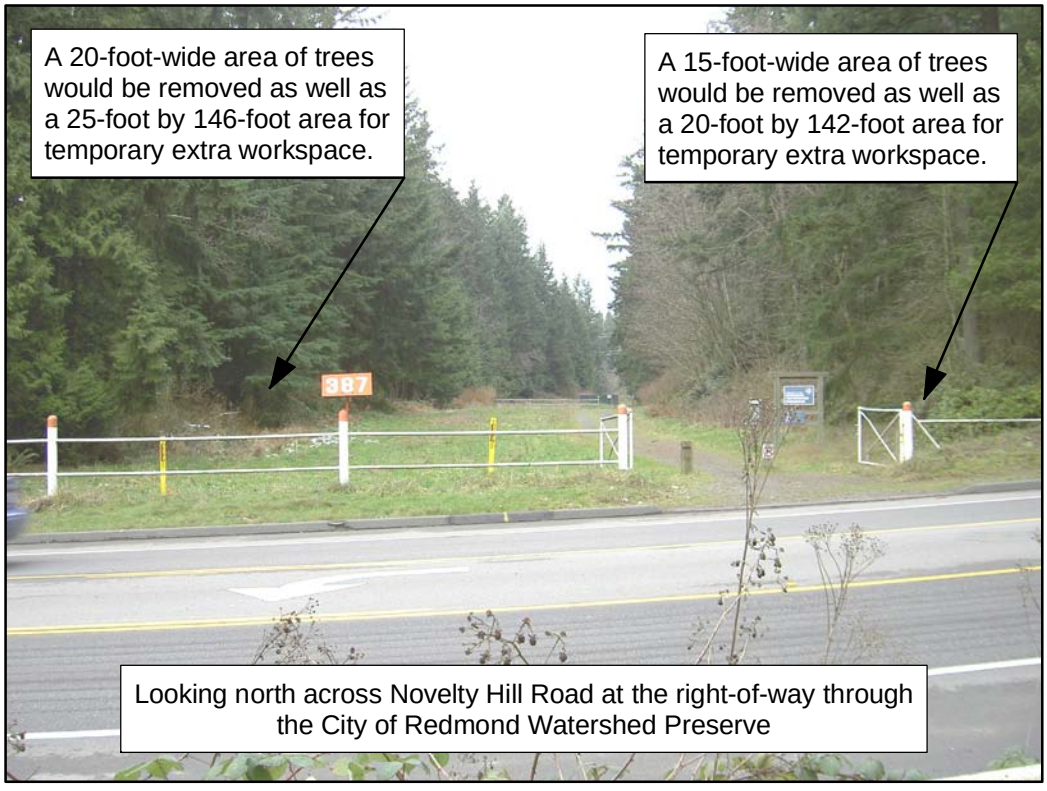


Figure Q-2
Capacity Replacement Project
Novelty Hill Road Key Observation Points

Figure Q-3
Capacity Replacement Project
Deer Park Subdivision Key Observation Points

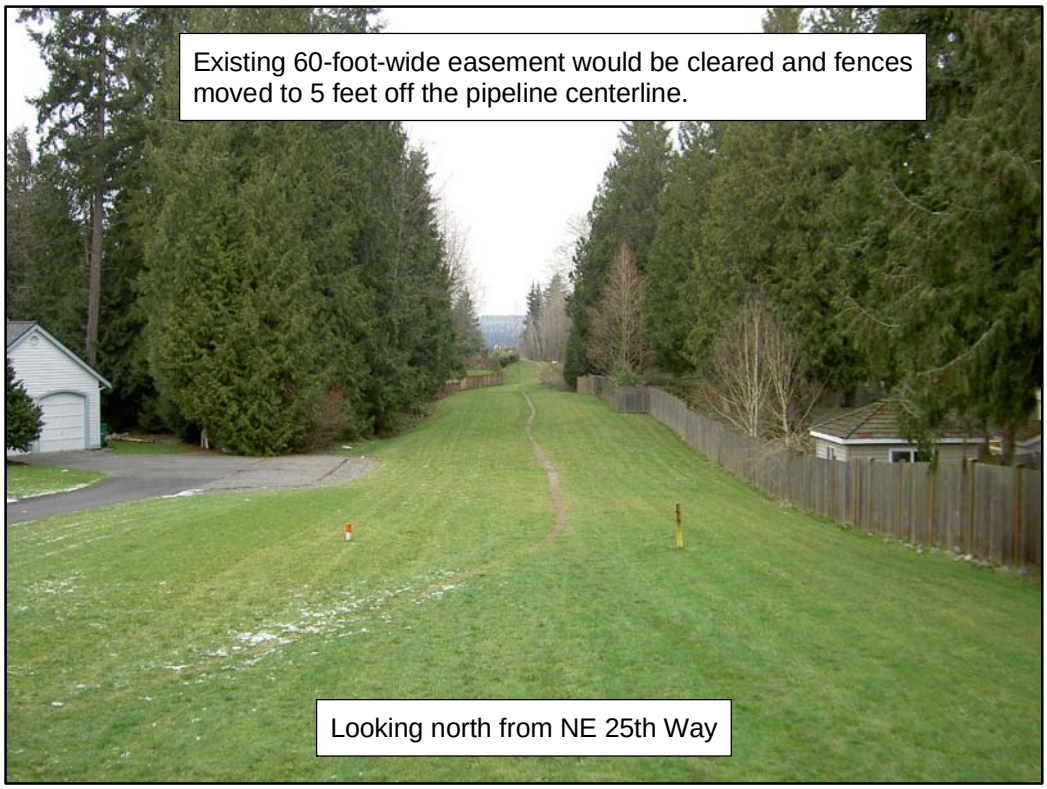


Figure Q-3
Capacity Replacement Project
Deer Park Subdivision Key Observation Points

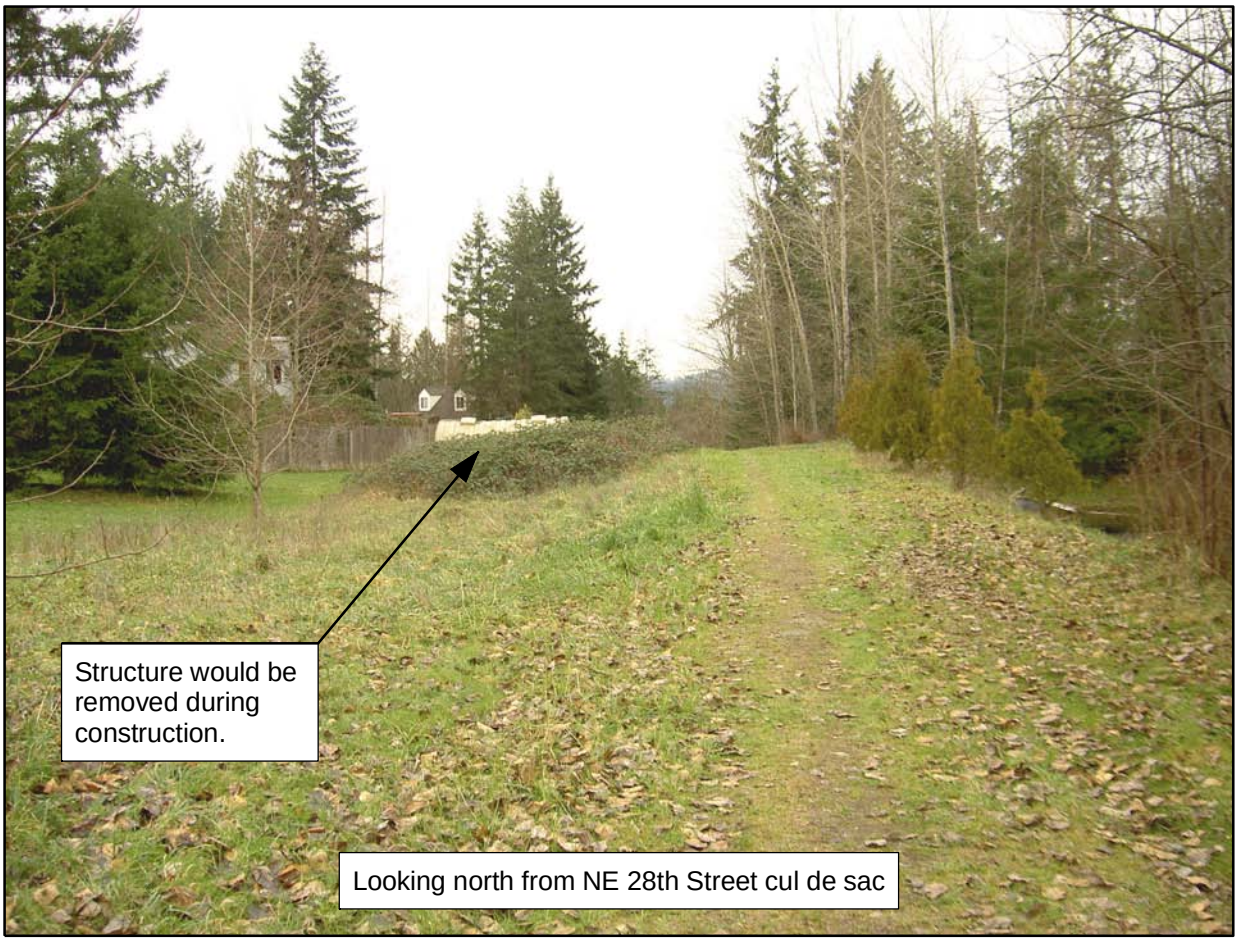


Figure Q-3
Capacity Replacement Project
Deer Park Subdivision Key Observation Points

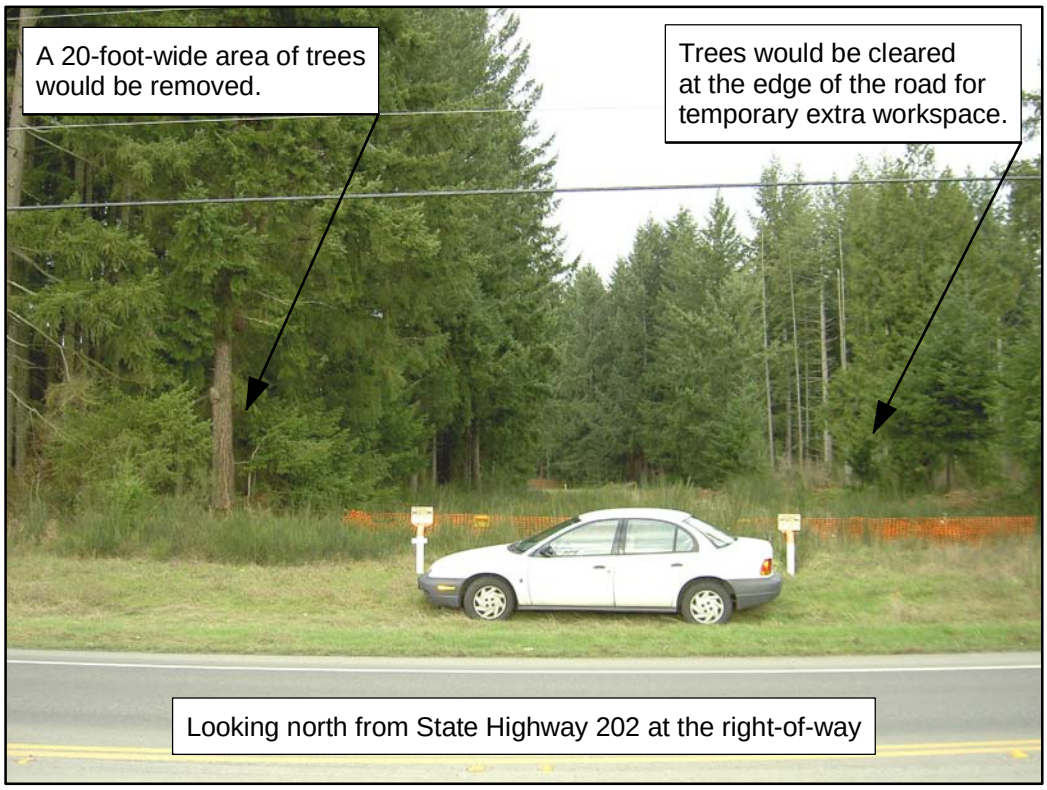
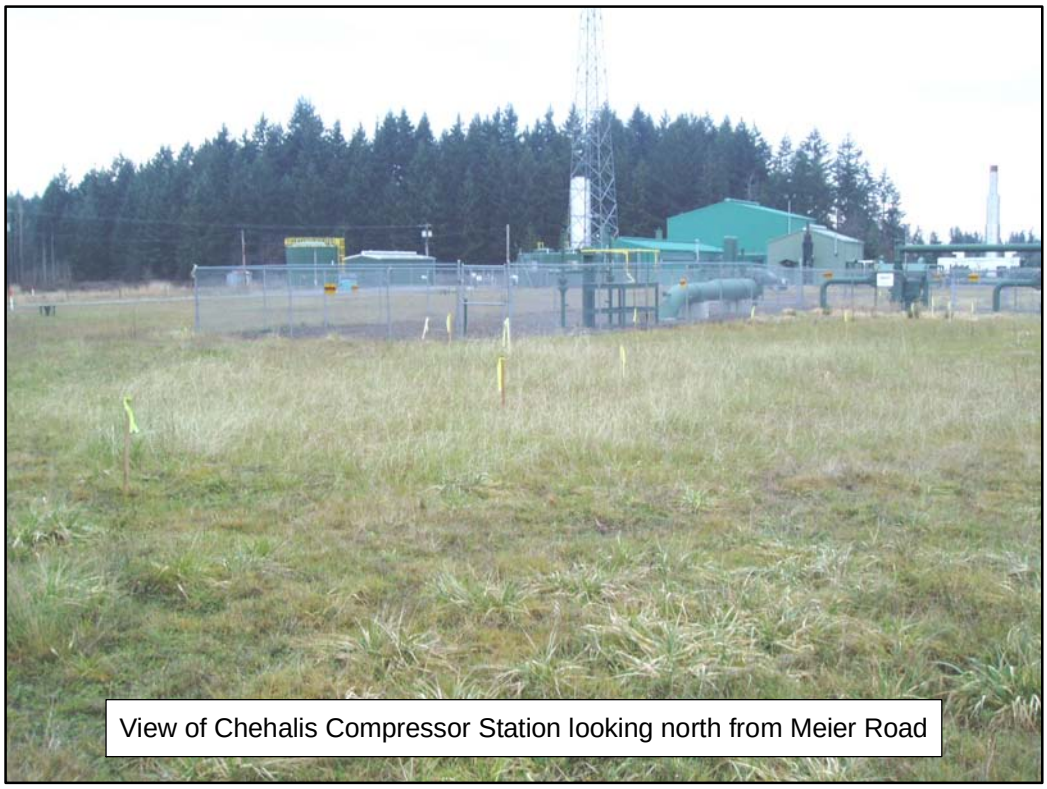


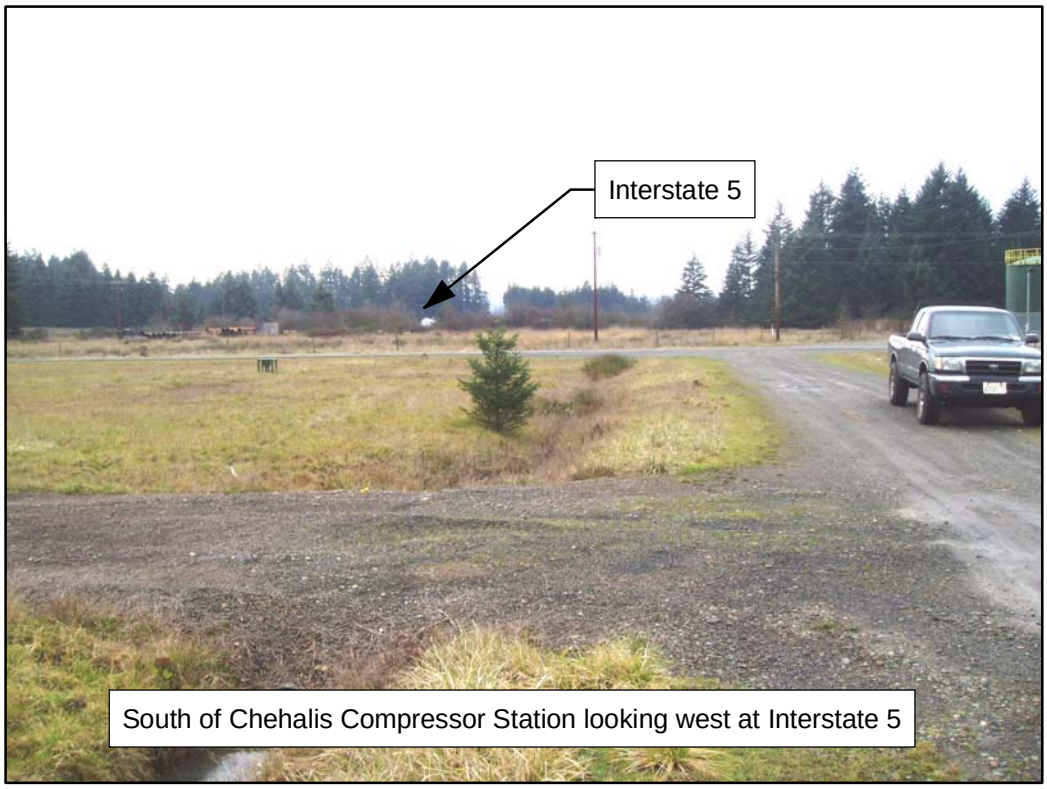
Figure Q-4
Capacity Replacement Project
State Highway 202 Key Observation Points



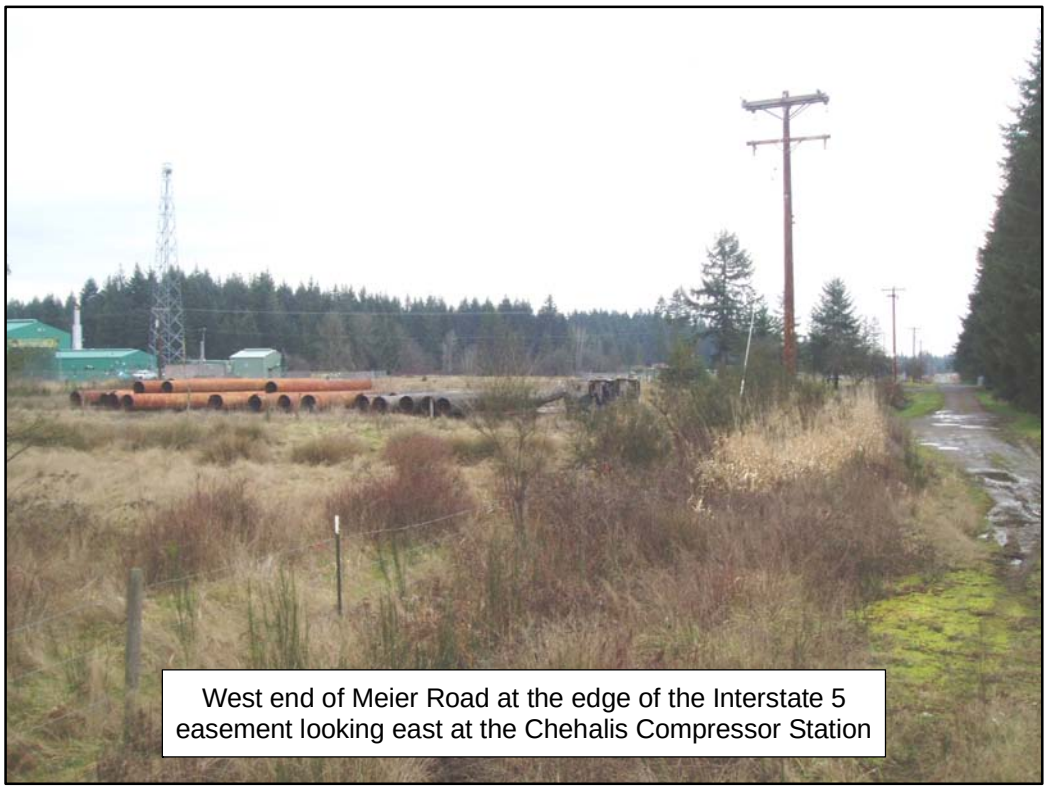
View of Chehalis Compressor Station looking north from Meier Road

View of Chehalis Compressor Station looking northwest from Meier Road

Figure Q-5
Capacity Replacement Project
Chehalis Compressor Station Key Observation Points



South of Chehalis Compressor Station looking west at Interstate 5



West end of Meier Road at the edge of the Interstate 5 easement looking east at the Chehalis Compressor Station

Figure Q-5
Capacity Replacement Project
Chehalis Compressor Station Key Observation Points

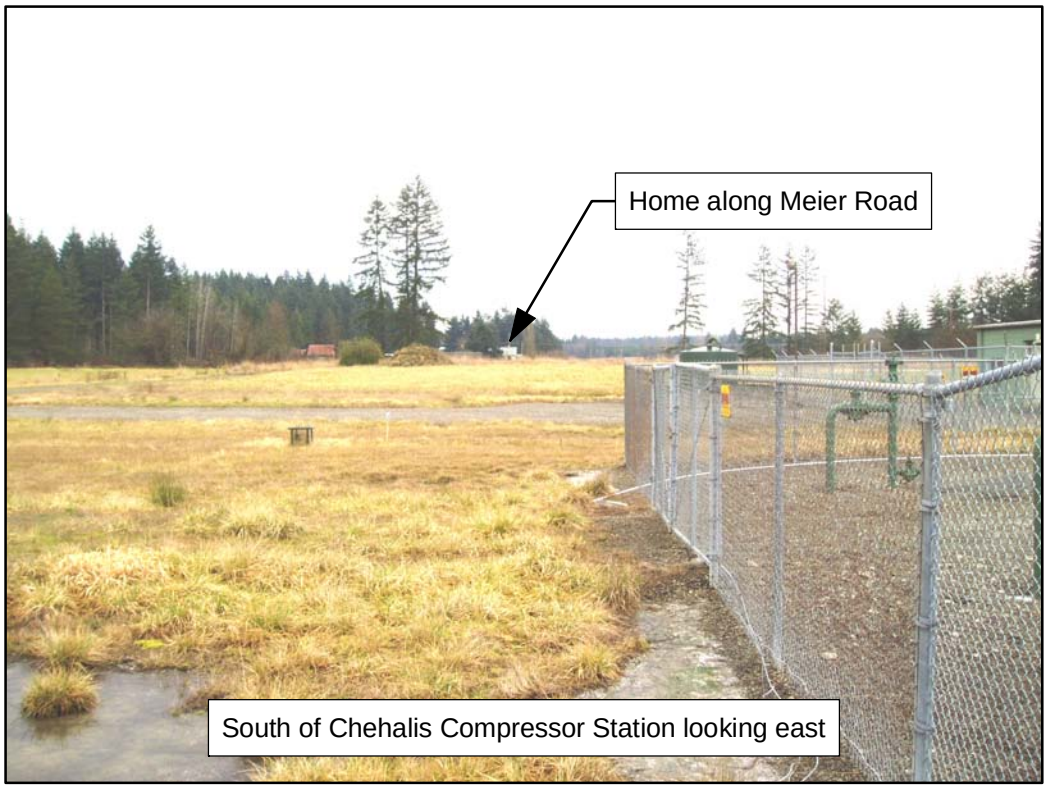


Figure Q-5
Capacity Replacement Project
Chehalis Compressor Station Key Observation Points

APPENDIX R

ROAD CROSSINGS, POTENTIAL CONSTRUCTION WORKER TRAVEL ROUTES, AND TYPICAL CONSTRUCTION CREWS AND EQUIPMENT ASSOCIATED WITH THE CAPACITY REPLACEMENT PROJECT

TABLE R-1

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
Sumas Loop				
Whatcom	1484.41	Jones Road	Paved	Open-cut
	1483.87	Rock Road	Paved	Open-cut
	1483.82	Clarke Road (not built yet)	Dirt	Open-cut
	1483.29	Trail	Dirt	Open-cut
	1483.00	Hillview Road	Paved	HDD/open-cut
	1482.86	Kendall Road (State Highway 27)	Paved	HDD/open-cut
	1482.23	Sumas Road (old railroad grade)	Dirt	Open-cut
	1481.66	Benner Ridge Circle	Gravel	Open-cut
	1481.61	Benner Ridge Drive	Gravel	Open-cut
	1481.52	Minaker Road	Paved	Open-cut
	1481.49	Robinson Driveway	Gravel	Open-cut
	1481.48	Private Drive off Minaker Road	Gravel	Open-cut
	1480.02	Kamphouse Driveway	Paved	Open-cut
	1480.01	North Pass Road	Paved	Open-cut
	1478.69	Private Drive off Lebrant Road	Gravel	Open-cut
	1478.61	Lebrant Road	Paved	Open-cut
	1478.38	Fuller Driveway	Gravel	Open-cut
	1478.24	Larsen Driveway	Gravel	Open-cut
	1478.22	Jrnel Driveway	Gravel	Open-cut
	1478.16	South Pass Road	Paved	Open-cut
	1477.88	Pen Driveway	Gravel	Open-cut
	1477.83	Ladwig Driveway	Gravel	Open-cut
	1477.64	Great Western Lumber Company Road	Dirt	Open-cut
	1477.39	Private Drive off Goodwin Road	Gravel	Open-cut
	1477.10	Private Drive off Gilmore Road	Gravel	Open-cut
	1476.96	Private Drive off Gilmore Road	Gravel	Open-cut
	1476.83	Gilmore Road	Paved	Open-cut
	1476.54	Private Drive off Goodwin Road	Gravel	Open-cut
	1476.29	Cabrant Road	Paved	Open-cut
	1476.03	Private Drive off Goodwin Road	Gravel	Open-cut
	1475.76	Private Drive off Ocean Road	Gravel	Open-cut
	1475.55	Hopewell Road	Paved	Open-cut
	1475.30	Wallace Lane	Gravel	Open-cut
	1474.96	Private Drive off Goodwin Road	Gravel	Open-cut
	1474.66	Trillium Corp. / DNR Timber Road #1	Gravel	Open-cut
	1474.19	Trillium Corp. / DNR Timber Road #3	Gravel	Open-cut
	1474.00	Trillium Rock Quarry Road	Paved	Bore
	1473.67	Hoff Lane	Gravel	Open-cut
	1473.49	Hoff Road	Paved	Open-cut
	1472.77	Private Road off Finsrud Road	Gravel	Open-cut
	1472.71	Private Road off Finsrud Road	Gravel	Open-cut
	1472.57	Finsrud Road	Gravel	Open-cut
	1472.39	Driveway to Log Home Manufacturer	Gravel	Open-cut
	1472.25	Road to Block Valves 17-8 & 17L-8	Gravel	Open-cut
	1472.12	Private Drive	Gravel	Open-cut
	1472.04	Hilliard Road	Gravel	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1471.68	Groot Driveway	Gravel	Bore
	1471.36	East 45th Drive	Gravel	Open-cut
	1470.92	Unnamed Road	Dirt	Open-cut
	1470.78	Webb Driveway	Gravel	Open-cut
	1470.67	Webb Driveway	Gravel	Open-cut
	1470.40	Engholm Driveway	Gravel	Open-cut
	1470.35	Mitchell Road	Gravel	Open-cut
	1470.31	Mitchell Driveway	Gravel	Open-cut
	1470.06	Schroeder Driveway	Gravel	Open-cut
	1469.95	Water Street	Gravel	Open-cut
	1469.24	Cronk Street	Gravel	Open-cut
	1469.15	Marshall Hill Road	Gravel	Open-cut
	1469.14	Forest Driveway	Gravel	Open-cut
	1468.91	Mount Baker Highway	Paved	Bore
	1468.12	Rutsatz Road	Paved	HDD/open-cut
	1467.43	Williams Lake Road	Gravel	Open-cut
	1467.01	Carroll Driveway	Gravel	Open-cut
	1466.73	Potter Road	Paved	Open-cut
	1466.33	Craig Driveway	Gravel	Open-cut
	1466.21	Baker Driveway off Nelson Road	Gravel	Open-cut
	1465.45	Nelson Road	Paved	Open-cut
	1464.73	Strand Road	Paved	Open-cut
	1463.75	Homesteader Road	Gravel	Open-cut
	1463.01	Wild Rose Road	Gravel	Open-cut
	1461.82	Mosquito Lake Road	Paved	Open-cut
Mount Vernon Loop				
Skagit	1431.25	WDNR Logging Road	Gravel	Open-cut
Snohomish	1429.72	Finn Settlement Road / 44th Avenue NE	Paved	Open-cut
	1429.56	Private Logging Road off Finn Settlement (extension of Road Below)	Gravel	Open-cut
	1429.16	Private Logging Road off Finn Settlement	Gravel	Open-cut
	1428.64	Private Drive off Highway 9 (forks into 2)	Gravel	Open-cut
	1428.51	Private Logging Road off Highway 9	Gravel	HDD/open-cut
	1428.48	Old Pipeline Construction Road off Logging Road	Dirt	HDD/open-cut
	1427.97	Power Line/Logging Road off Main Logging Road	Gravel	Open-cut
	1427.60	59th NE Avenue / Tree Farm Road	Paved	Open-cut
	1427.53	Private Drive off 59th Avenue to block valves	Gravel	Open-cut
	1427.49	Private Drive off 59th Avenue	Gravel	Open-cut
	1427.43	Private Drive off 59th Avenue	Gravel	Open-cut
	1427.35	Private Drive	Gravel	Open-cut
	1426.76	Unnamed Road	Dirt	Open-cut
	1426.66	Grandview Road	Paved	Open-cut
	1425.84	Hammond Rhododendron Nursery Driveway	Gravel	Open-cut
	1425.78	Private Drive off Hammond Rhododendron Nursery Driveway	Gravel	Open-cut
	1424.74	Lake Armstrong Road	Paved	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1424.15	State Highway 530	Paved	HDD/bore
	1424.14	Private Drive off Highway 530 (Mulally)	Dirt	HDD/open-cut
	1424.07	Private Drive off Highway 530	Gravel	Open-cut
	1424.06	Private Drive off Highway 530	Gravel	Open-cut
	1423.97	Arlington Heights Road (234th Street NE)	Paved	HDD/bore
	1423.49	Country Charm Dairy Farm Road / Gilman Avenue	Gravel	HDD/open-cut
	1422.59	92nd Avenue NE	Gravel	Open-cut
	1422.41	212th Street NE / Tueit Road	Paved	Open-cut
	1421.98	Baily Driveway	Gravel	Open-cut
	1421.89	Eskelin Driveway	Gravel	Open-cut
	1421.82	97th Avenue NE – located in permanent easement	Gravel	Parallel open-cut on west edge of road
	1421.72	200th Street NE	Paved	Open-cut
	1421.26	Bowen Driveway	Gravel	Open-cut
	1420.62	Mosses / Murril Driveway	Gravel	Open-cut
	1420.61	Burn Road	Paved	Open-cut
	1420.07	Private Drive off Burn Road	Gravel/Dirt	Open-cut
	1419.10	Private Drive off 156th Street NE (Power Line Road)	Gravel	Open-cut
	1418.75	156th Avenue NE	Paved	Open-cut
	1418.65	Bell Driveway	Gravel	Open-cut
	1418.38	Private Drive off 111th (Shoemaker)	Gravel	Open-cut
	1418.18	Logging Road	Gravel	Open-cut
	1416.41	120th Street (Beechcraft Drive)	Paved	Open-cut
	1415.91	112th Street NE (Lady Hawke Subdivision)	Paved	Open-cut
	1415.83	Private Drive off of 123rd Avenue NE	Paved	Open-cut
	1415.81	123rd Avenue NE	Paved	Open-cut
	1415.78	Private Drive off of 123rd Avenue NE	Gravel	Open-cut
	1415.52	107th Street	Paved	Open-cut
	1415.18	Private Drive off of 123rd Avenue NE	Gravel	Open-cut
	1415.10	Private Drive	Gravel	Open-cut
	1415.04	Private Drive	Gravel	Open-cut
	1414.91	Private Drive off of 123rd Avenue NE	Gravel	Open-cut
	1414.86	96th Street NE	Gravel	Open-cut
	1414.72	Private Road off of 123rd Avenue NE (Tree Farm Road)	Gravel	Open-cut
	1414.10	84th Street NE / Getchell Road	Paved	Open-cut
	1413.85	Private Drive off of 123rd Avenue NE	Gravel	Open-cut
	1413.66	77th Street NE	Gravel	Open-cut
	1413.32	Private Drive off of 68th Street NE	Gravel	Open-cut
	1413.26	Private Drive off of 68th Street NE	Gravel	Open-cut
	1413.10	68th Street NE/Benson Road	Paved	Open-cut
	1412.60	60th Street NE	Gravel	Open-cut
	1411.96	Private Drive	Gravel	Open-cut
	1411.73	Private Drive off of 44th Street NE	Gravel	Open-cut
	1411.59	44th Street NE	Paved	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1411.37	State Highway 92	Paved	Bore
	1411.33	Northwest Pipeline Valve Yard Driveway	Gravel	Open-cut
	1411.14	Hartford-Machias Road/131st Street NE	Paved	Open-cut
	1411.09	Private Drive off Hartford-Machias Road	Gravel	Open-cut
	1410.92	Private Drive	Gravel	Open-cut
	1410.79	134th Avenue NE	Gravel	Open-cut
	1410.60	28th Street NE	Paved	Open-cut
	1410.28	Private Road off Hartford-Machias Road (Perma Gas)	Gravel	Open-cut
	1410.27	Withrow Driveway	Gravel	Open-cut
	1410.08	Private Drive	Gravel	Open-cut
	1409.98	Norgaard Wood Products Driveway	Gravel	Open-cut
	1409.97	Hartford-Machias Road/131st Street NE	Paved	Open-cut
	1409.96	Centennial Trail	Paved	Open-cut
	1409.82	Northwest Pipeline Lake Stevens Meter Station Driveway	Gravel	Open-cut
	1409.79	16th Street NE / Robinett Road	Paved	Open-cut
	1409.78	Private Drive	Gravel	Open-cut
	1409.76	Private Drive	Gravel	Open-cut
	1409.75	Private Drive off of 16th Street NE	Gravel	Open-cut
Snohomish Loop				
Snohomish	1393.72	234th Street SE	Paved	Open-cut
	1393.66	Unnamed Street	Gravel	Open-cut
	1393.47	238th Street SE	Paved	Open-cut
King	1392.32	Private Drive	Gravel	Open-cut
	1392.17	Private Drive	Gravel	Open-cut
	1391.67	Private Drive	Gravel	Open-cut
	1391.61	186th Avenue NE	Gravel	Open-cut
	1391.45	214th Avenue NE	Paved	Open-cut
	1391.44	Meter Station drive	Gravel	Open-cut
	1391.33	Woodinville Duvall Road NE	Paved	Bore
	1391.05	165th Street NE	Paved	Open-cut
	1391.03	Private Drive	Gravel	Open-cut
	1390.99	164th Street NE	Paved	Open-cut
	1390.90	Private Drive	Gravel	Open-cut
	1390.85	161st Street NE	Paved	Open-cut
	1390.72	159th Street NE	Paved	Open-cut
	1390.64	Private Drive	Gravel	Open-cut
	1390.59	156th Street NE	Paved	Open-cut
	1390.54	Private Drive	Gravel	Open-cut
	1390.51	Private Drive	Gravel	Open-cut
	1390.49	Private Drive	Gravel	Open-cut
	1390.46	154th Street NE	Paved	Open-cut
	1390.42	Private Drive	Gravel	Open-cut
	1390.37	Private Drive	Gravel	Open-cut
	1390.33	Private Drive	Gravel	Open-cut
	1390.26	151st Street NE	Paved	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1390.17	Private Drive	Gravel	Open-cut
	1390.08	Private Drive	Paved	Open-cut
	1390.04	Private Drive	Gravel	Open-cut
	1389.93	NE 144th Place	Paved	Open-cut
	1389.86	Water Line	NA	Open-cut
	1389.59	141st Street NE	Paved	Open-cut
	1389.49	214th Way NE	Paved	Open-cut
	1389.32	NE 139th St	Paved	Open-cut
	1388.98	133rd Street NE	Paved	Bore
	1387.67	Walking Trail	Dirt	Open-cut
	1387.62	Walking Trail	Dirt	Open-cut
	1387.61	Walking Trail	Dirt	Open-cut
	1387.59	Water Line	NA	Open-cut
	1387.57	Walking Trail	Dirt	Open-cut
	1387.53	Walking Trail	Dirt	Open-cut
	1387.33	Novelty Hill Road NE	Paved	Bore
	1386.74	Bridle Crossing Way NE	Paved	Bore
	1386.31	Private Drive	Gravel	Open-cut
	1386.19	85th Street NE	Paved	Open-cut
	1386.01	Private Drive	Gravel	Open-cut
	1385.92	Private Drive	Dirt	Open-cut
	1385.85	Private Drive	Dirt	Open-cut
	1385.79	76th Street NE	Paved	Open-cut
	1385.41	Union Hill Road NE	Paved	Bore/possible open-cut
	1385.38	Meter Station Road	Gravel	Open-cut
	1385.09	Private Drive	Gravel	Open-cut
	1384.94	60th Street NE	Paved	Open-cut
	1384.82	Private Drive	Gravel	Open-cut
	1384.75	57th Court NE	Paved	Open-cut
	1384.68	Private Drive	Gravel	Open-cut
	1384.63	Private Drive	Gravel	Open-cut
	1384.62	Private Drive	Gravel	Open-cut
	1384.59	Private Drive	Gravel	Open-cut
	1384.59	Private Drive	Gravel	Open-cut
	1384.50	Private Drive	Gravel	Open-cut
	1384.46	Private Drive	Gravel	Open-cut
	1384.44	228th Avenue NE	Paved	Open-cut
	1384.27	47th Street NE	Paved	Open-cut
	1383.90	State Highway 202/Redmond Fall City Road	Paved	Bore
	1383.88	Private Drive	Gravel	Open-cut
	1383.76	Private Drive	Gravel	Open-cut
	1382.98	25th Way NE	Paved	Open-cut
	1382.74	19th Drive NE	Paved	Open-cut
	1382.54	18th Place NE	Paved	Open-cut
	1382.31	15th Place NE	Paved	Open-cut
	1382.22	Private Drive	Gravel	Open-cut
	1382.21	Development road	Dirt	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1382.18	14th Street	Paved	Open-cut
	1382.10	14th Street	Paved	Open-cut
	1382.09	Trail	Dirt	Open-cut
Fort Lewis Loop				
Pierce	1337.97	Private Drive	Gravel	Open-cut
	1337.58	200th Street E / Orting Prairie Road	Paved	Bore
	1337.12	Private Drive	Gravel	Open-cut
	1337.10	46th Avenue E	Paved	Open-cut
	1337.02	208th Street E	Paved	Open-cut
	1336.89	Private Drive	Gravel	Open-cut
	1336.88	44th Avenue E	Paved	Open-cut
	1336.54	214th Street E	Paved	Open-cut
	1336.35	38th Avenue E	Paved	Bore
	1336.26	217th Street E	Paved	Open-cut
	1335.87	35th Avenue E	Paved	Open-cut
	1335.77	224th Street E	Paved	Bore
	1335.66	225th Street Ct E	Gravel	Open-cut
	1335.59	226th Street Ct E	Gravel	Open-cut
	1335.52	227th Street E	Gravel	Open-cut
	1335.49	32nd Avenue E	Gravel	Open-cut
	1335.43	Private Drive	Gravel	Open-cut
	1335.26	Private Drive	Gravel	Open-cut
	1335.21	State Highway 7 / Mountain Highway E	Paved	Bore
	1334.43	Private Road	Dirt	Open-cut
	1333.08	Rice Candle Road / Goodacres Road	Paved	Open-cut
	1332.94	8th Avenue E	Paved	Open-cut
	1332.88	Private Road	Gravel	Open-cut
	1332.86	Private Road	Gravel	Open-cut
	1332.80	Private Road	Gravel	Open-cut
	1332.72	Private Road	Gravel	Open-cut
	1332.67	Private Road	Gravel	Open-cut
	1332.33	Private Road	Gravel	Open-cut
	1332.00	Private Road	Gravel	Open-cut
	1331.93	Private Road	Gravel	Open-cut
	1331.92	Private Road	Gravel	Open-cut
	1331.63	Private Road	Gravel	Open-cut
	1331.50	Private Road	Gravel	Open-cut
	1331.30	8th Avenue S / Harts Lake Loop	Paved	Open-cut
	1331.18	Private Road	Gravel	Open-cut
	1331.03	Private Road	Gravel	Open-cut
	1330.87	Private Road	Gravel	Open-cut
	1330.72	Unnamed Road	Gravel	Open-cut
	1330.60	Private Road	Gravel	Open-cut
	1330.58	288th Street S / Zephrow Plowmacher	Paved	Bore
	1330.41	Private Drive	Gravel	Open-cut
	1329.91	Schudy Road S	Paved	Open-cut
	1329.73	24th Avenue S	Gravel	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1329.47	304th Street S	Gravel	Open-cut
	1329.31	Private Drive	Gravel	Open-cut
	1329.26	29th Avenue S	Gravel	Open-cut
	1329.24	Private Drive	Gravel	Open-cut
	1328.68	Private Road	Gravel	Open-cut
	1328.26	40th Avenue S / Hawk Peterson Road	Paved	Open-cut
	1327.57	Private Road	Gravel	Open-cut
	1327.46	48th Avenue S	Paved	Open-cut
	1327.39	Private Drive	Gravel	Open-cut
	1326.85	54th Avenue S	Gravel	Open-cut
	1326.67	Tisch Road S	Paved	Open-cut
	1326.47	Coffel Road S	Paved	Open-cut
	1325.61	Private Drive	Gravel	Open-cut
	1325.57	348th Street S	Paved	Open-cut
	1325.20	State Highway 702	Paved	Bore
	1325.06	Private Drive off 74th Avenue S	Gravel	Open-cut
	1325.01	74th Avenue S	Paved	Open-cut
	1324.63	Harts Lake Loop Road	Paved	Bore
	1324.45	360th St. S	Gravel	Open-cut
Thurston	1323.97	Private Drive	Gravel	Open-cut
	1323.84	Centralia Canal Road	Gravel	Open-cut
	1323.78	Cook Road SE	Paved	Bore
	1323.73	Private Drive	Gravel	Open-cut
	1323.54	Chause Lane SE	Gravel	Open-cut
	1323.39	Chause Lane SE	Gravel	Open-cut
	1323.03	Private Drive	Gravel	Open-cut
	1322.95	Bald Hill Road SE	Paved	Bore
	1322.82	Private Drive	Gravel	Open-cut
	1323.06	Private Drive	Gravel	Open-cut
	1322.68	Private Drive	Gravel	Open-cut
	1322.67	120th Avenue SE	Gravel	Open-cut
	1322.66	Private Drive	Gravel	Open-cut
	1322.64	Private Drive	Gravel	Open-cut
	1322.41	Private Drive	Gravel	Open-cut
	1322.38	Witland Lane SE	Gravel	Open-cut
	1322.35	Private Drive	Gravel	Open-cut
	1322.00	Private Gravel Drive off Vail Loop Road SE	Gravel	Open-cut
	1321.98	Private Drive	Gravel	Open-cut
	1321.86	Private Drive	Gravel	Open-cut
	1321.43	Private Drive	Gravel	Open-cut
	1321.17	Private Drive	Gravel	Open-cut
	1321.06	Loop off Rocking Lane SE	Gravel	Open-cut
	1321.02	Rocking Lane SE	Gravel	Open-cut
	1320.53	Vail Road SE	Paved	Bore
	1320.36	Private Drive	Gravel	Open-cut
	1319.98	Private Drive	Gravel	Open-cut
	1319.75	Morris Road SE	Paved	Bore
	1319.63	143rd Avenue SE	Paved	Open-cut

TABLE R-1 (cont'd)

Roads Crossed by the Loops Associated with the Capacity Replacement Project

Facility/County	Milepost	Road Name	Surface	Proposed Crossing Method
	1319.10	Martinson Street SE	Paved	Open-cut
	1318.86	Private Drive	Gravel	Open-cut
	1318.77	148th Avenue SE	Paved	Bore
	1318.56	Private Drive	Gravel	Open-cut
	1318.40	Private Drive	Gravel	Open-cut
	1318.12	Fallow Lane	Gravel	Open-cut
	1317.86	Private Drive	Gravel	Open-cut
	1317.85	McIntosh Lane SE	Gravel	Open-cut
	1316.99	Private Drive	Gravel	Open-cut
	1316.95	Private Drive	Gravel	Open-cut
	1316.84	Private Drive	Gravel	Open-cut
	1316.81	Runyon Road SE	Paved	Bore
	1317.39	Private Drive	Gravel	Open-cut
	1316.72	Private Drive	Gravel	Open-cut
	1316.68	Private Drive	Gravel	Open-cut
	1316.66	Private Drive	Gravel	Open-cut
	1316.43	Vail Cutoff SE	Paved	Bore
	1316.09	Private Road	Gravel	Open-cut
	1315.89	Vail Loop Road SE	Paved	Bore
	1315.74	Private Drive	Gravel	Open-cut

NA = Not applicable.

TABLE R-2

Potential Construction Worker Travel Routes Along the Sumas Loop

Facility	Origin/Route	
	Bellingham	Mount Vernon
Sumas Industrial Park Yard	North on SR 539 (Guide Meridian Road) to SR 546. East on SR 546 to SR 9. North on SR 9 to Sumas. North on Bob Mitchell Ave. to yard.	North on I-5 to SR 20 (Exit 229). East on SR 20 to SR 9 (Sedro-Woolley). North on SR 9 to Sumas. North on Bob Mitchell Road to yard.
Jones Road Yard (Lots 1 and 2)	North on SR 539 (Guide Meridian Road) to SR 546. East on SR 546 to SR 9. North on SR 9 to Sumas. East on Jones Road to yard.	North on I-5 to SR 20 (Exit 229). East on SR 20 to SR 9 (Sedro-Woolley). North on SR 9 to Sumas and Jones Road. East on Jones Road to yard.
Bellingham GSX Yard	North on I-5 north to Birch Bay Lynden Road (Exit 271). West on Birch Bay Lynden Road to Portal Way. North on Portal Way to yard.	North on I-5 north to Birch Bay Lynden Road (Exit 271). West on Birch Bay Lynden Road to Portal Way. North on Portal Way to yard.
Nooksack Yard	West on SR 542 (Mount Baker Highway) to SR 9. North of SR 9 to Nooksack. Through Nooksack on SR 9 (Nooksack Road) to Baird Road and yard.	North on I-5 to SR 20 (Exit 229). East on SR 20 to SR 9 (Sedro-Woolley). North on SR 9 to Nooksack. Through Nooksack on SR 9 (Nooksack Road) to Baird Road and yard.

TABLE R-3

Potential Construction Worker Travel Routes Along the Mount Vernon Loop

Facility	Origin/Route	
	Everett	Arlington
Burlington Yard	North on I-5 to Exit 231. East on N. Garl St. to Old Highway 99 N. North on Old Highway 99 N to N. Hill Blvd. East on N. Hill Blvd. to Park Lane. South on Park Lane to yard.	East on SR 530 to I-5. North on I-5 to Exit 231. East on N. Garl St. to Old Highway 99 N. North on Old Highway 99 N to N. Hill Blvd. East on N. Hill Blvd. to Park Lane. South on Park Lane to yard.
Skagit Yard	North on I-5 to SR 20 (Exit 229). East on SR 20 to SR 9 (Sedro-Woolley) and Metcalf Street. South on Metcalf Street to yard.	East on SR 530 to I-5. North on I-5 to SR 20 (Exit 229). East on SR 20 to Sedro-Woolley and Metcalf Street. South on Metcalf Street to yard.
Arlington Yard	North on I-5 to 172nd St. NE (Exit 206). East on 172nd St. NE to 67th Ave. NE and yard.	Various city roads.
Second Arlington Yard	North on I-5 to 172nd St. NE (exit 206). East on 172nd St. NE to 67th Ave. NE. North on 67th Ave. to 191st Place NE and yard.	Various city roads.

TABLE R-4

Potential Construction Worker Travel Routes Along the Snohomish Loop

Facility	Origin/Route	
	Bellevue	Renton
Maltby 1a and 1b Yards	North on I-405 to SR 522 (Exit 23B). East on SR 522 to Paradise Lake Road/Yew Way. North on Yew Way to 212th St. SE. West on 212th St. SE to yard.	North on I-405 to SR 522 (Exit 23B). East on SR 522 to Paradise Lake Road/Yew Way. North on Yew Way to 212th St. SE. West on 212th St. SE to yard.
Maltby 2a, 2b, and 2c Yards	North on I-405 to SR 522 (Exit 23B). East on SR 522 to Paradise Lake Road/Yew Way. North on Yew Way to 212th St. SE. West on 212th St. SE to yard.	North on I-405 to SR 522 (Exit 23B). East on SR 522 to Paradise Lake Road/Yew Way. North on Yew Way to 212th St. SE. West on 212th St. SE to yard.

TABLE R-5

Potential Construction Worker Travel Routes Along the Fort Lewis Loop

Facility	Origin/Route				
	Tacoma	Puyallup	Fife	Olympia	Lacey
4647 – 192nd Yard	South on I-5 to SR 512. East to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to yard.	West on SR 512 to Canyon Road E. South on Canyon Road E to 192nd E. St. West on 192nd E St. to yard.	South on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th to 38th Ave. E. South on 38th Ave. E to yard.	North on I-5 to SR 512. East to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to yard.	North on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to yard.
4667 – 192nd Yard	South on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th St. to 38th Ave. E. South on 38th Ave. E to 192nd St. E. East on 192nd St. E to yard.	West on SR 512 to Canyon Road E. South on Canyon Road E to yard.	South on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to 192nd St. E. East on 192nd St. E to yard.	North on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to 192nd St. E. East on 192nd St. E to yard.	North on I-5 to SR 512. East on SR 512 to SR 7. South on SR 7 to 176th St. E. East on 176th St. E to 38th Ave. E. South on 38th Ave. E to 192nd St. E. East on 192nd St. E to yard.
Yelm Yard	South on 1-5 to Nisqually Road/Old Pacific Highway SE (Exit 116). South on Old Pacific Highway SE to SR 510. East on SR 510 to 1st St. NE (Yelm). North on 1st St NE to Rhoton Road. North on Rhoton Road to Railroad Ave. NW. North on Railroad Ave. NW to yard.	West on SR 512 to I-5. South on 1-5 to Nisqually Road/Old Pacific Highway SE (Exit 116). South on Old Pacific Highway SE to SR 510. East on SR 510 to 1st St. NE (Yelm). North on 1st St NE to Rhoton Road. North on Rhoton Road to Railroad Ave NW. North on Railroad Ave NW to yard.	South on 1-5 to Nisqually Road/Old Pacific Highway SE (Exit 116). South on Old Pacific Highway SE to SR 510. East on SR 510 to 1st St. NE (Yelm). North on 1st St. NE to Rhoton Road. North on Rhoton Road to Railroad Ave. NW. North on Railroad Ave. NW to yard.	North on I-5 to Marvin Road SE (Exit 111). South on Marvin Road to Pacific Highway SE/SR 510. East on SR 510 to 1st St. NE (Yelm). North on 1st St NE to Rhoton Road. North on Rhoton Road to Railroad Ave NW. North on Railroad Ave. NW to yard.	South on Marvin Road to Pacific Highway SE/SR 510. East on SR 510 to 1st St. NE (Yelm). North on 1st St NE to Rhoton Road. North on Rhoton Road to Railroad Ave NW. North on Railroad Ave. NW to yard.

TABLE R-6

Potential Construction Worker Travel Routes to the Compressor Stations

Facility/Origin	Travel Route
Mount Vernon Compressor Station	
Sedro-Woolley	South on SR 9 to Beaver Lake Road. South on Beaver Lake Road to Lange Road. North on Lange Road to compressor station.
Mount Vernon	East on College Way (SR 538) to SR 9. North on SR 9 to Gunderson Road. East on Gunderson Road to Lange Road. North on Lange Road to compressor station.
Snohomish Compressor Station	
Bellevue	North on I-405 to SR 522. East on SR 522 to Echo Lake Road. South on Echo Lake Road to compressor station.
Bothell	South on I-405 to SR 522. East on SR 522 to Echo Lake Road. South on Echo Lake Road to compressor station.
Chehalis Compressor Station	
Centralia	South on I-5 to SR 12 (Exit 68). East on SR 12 to Meier Road. South on Meier Road to W. Meier Road. West on W. Meier Road to compressor station.
Washougal Compressor Station	
Vancouver	West on Lewis and Clark Highway (SR 14) to SR 140 (Washougal). North on SR 140 to SE Blair Road. West on SE Blair Road to NE Zeek Road. East on Zeek Road to NE Brown Road. North on Brown Road to compressor station.

TABLE R-7

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
Clearing (to include timber crew)	Dozers (D8)		0
	Excavators		6
	Skidders		2
	Front-end track loaders		0
	Tub grinders		3
	Stump grinders		3
	Hot saws		1
	Processors		1
	Mat haulers (articulating 8 wheel dr.)		2
	Mowers		3
	Recyclers		1
	Chippers		2
	Rake tractors		3
	Fuel trucks		1
	Service trucks		1
	Tractors/low boy trailers		2
	Tractors w/ floats		2
	Log trucks		4
	1-ton trucks (with tools)		3
		Operator foreman	2
		Straw boss	2
		Operators	15
		Loggers	4
		Teamsters	13
		Laborers	25
		Oilers/swampers	13
	Buses for loggers		1
	Pickups		17
Environmental crew			
	1-ton trucks		2
	Gators (John Deer)		2
	Ditch witches (silt fence)		2
	Pickups		3
		Foreman	2
		Straw boss	2
		Teamsters	2
		Swampers	2
		Operators	4
		Laborers	18
Grade right-of-way	Dozers (D8)		2
	Dozers (D7)		2

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
	Excavators		2
	Tractors/low boy trailers		1
	End dump trucks		0
		Operator foreman	1
		Straw boss	1
		Operators	6
		Teamsters	1
		Laborers	1
		Oilers	1
	1-ton trucks (with tools)		1
	Pickups		8
26-inch-diameter pipe removal, cut up, haul off, offloading, skids, storage			
	Excavators (with pipe shoe)		3
	Trenchers		0
	Dozers (D6)		1
	John Henry (hoe with drill)		0
	1-ton trucks (with tools)		2
	Long-end dump trucks		2
	Trucks w/ float		4
	185 air compressors		2
	Air spades		4
	Sidebooms (583)		3
	Welding rigs		4
	Cranes (offload)		1
		Foreman	1
		Straw boss	1
		Operators	8
		Teamsters	8
		Oilers	8
		Laborers	12
		Welders	4
		Welder helpers	4
	Pickups		10
Total trench			
	Excavators		8
	Trenchers		0
	Dozers (D6)		3
	John Henry		1
	1-ton trucks (with tools)		2
	End dump trucks		0
	Hammers		2
	185 air compressors		2
	Air spades		2
		Foreman	1

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
		Straw boss	1
		Operators	12
		Teamsters	2
		Oilers	2
		Laborers	12
		Powder monkeys	0
	Pickups		14
Load, haul, string			
	Cranes		1
	Fork lifts		1
	Dozers (D6 for pulling trucks)		1
	Excavators with suction (in place of sideboom) 375 cat		1
	Tractors/float		1
	Boom trucks		2
	3-ton trucks		2
	Stringing trucks		6
		Foreman	1
		Straw boss	1
		Operators	4
		Teamsters	11
		Laborers	16
		Oilers	5
	Buses		1
	Pickups		6
Bend, line up, weld			
	Bending machines		1
	Sidebooms (583)		4
	Internal clamps		1
	Tack rigs		2
	Welding rigs		16
	1-ton trucks for buffers		1
	Generators		2
	Line up clamps		5
		Bending engineer	1
		Bending man	1
		Operators	7
		Pipe foreman	1
		Welder foreman	1
		Straw boss (pipe man helper)	1
		Spacers	2
		Stabbers	1
		Welders	16

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
		Welder helpers	16
		Laborers	15
	Pickups		11
	Buses		1
Jeep, field joint, patch			
	Wench trucks		2
	1-ton trucks		2
	Sand pots		4
	185 air compressors		4
	Flocking machines		2
	Sidebooms (572)		2
	Sand blast sand		850
	Coating skids		2
		Coating Foreman	2
		Straw Boss	2
		Operators	2
		Teamsters	4
		Oilers	4
		Laborers	10
	Buses		1
	Pickups		6
Lower-in			
	Excavators (clam)		2
	Sidebooms (583)		5
	Dozers (D7)		1
	Skid trucks		2
	1-ton trucks with tools		2
		Foreman	1
		Straw boss	1
		Operators	8
		Teamsters	4
		Laborers	8
		Oilers	4
		Additional laborers	8
	Pickups		10
	Buses		1
Furnish, haul, and install pad dirt from source other than spoil			
	Dump trucks		0
	Dump trucks		0
	580 rubber-tire backhoes		0
	Operators		
	Quary spalls		
	Sand		0

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
	Cdf		0
Pad ditch from spoil bank			
	Ozzie padders		2
	50,000 lb excavators		2
	1-ton trucks		2
		Foreman	1
		Operators	4
		Teamsters	2
		Laborers	6
		Oilers	2
	Pickups		5
Backfill			
	Excavator/trackhoes		4
	Dozers (D6)		1
	Skid trucks		1
		Foreman	1
		Straw boss	1
		Operators	5
		Teamsters	1
		Laborers	7
		Oilers	1
		Laborers (placement)	8
	Pickups		7
	Buses		1
Loose end tie-ins			
	Sidebooms (583)		6
	50,000 lb excavators		6
	Tractors/lowboy trailers		1
	Boom trucks		1
	1-ton trucks w/tools		3
	Skid trucks		3
	Sand pots		1
	185 air compressors		1
	Flocking machines		1
	Welding rigs		6
		Foreman	3
		Straw boss	3
		Operators	12
		Welders	6
		Welder helpers	6
		Teamsters	8
		Oilers	8
		Laborers	20

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
	Buses		1
	Pickups		18
Hydrostatic test and dry			
	Water trucks		
	Fill pumps		1
	Transfer pumps		1
	Test rigs		1
	Test trailers		1
	Pigs poly		20
	Pigs drying		150
	Brush pigs		2
	Caliper pigs		1
	1,800 air compressors		2
	Dehydrators		1
	2-ton w/float		1
	Boom trucks		1
		Testing man	1
		Laborers	2
		Teamsters	2
		Oilers	2
	Dewater structures		4
	Tanks		10
Final tie-ins			
	Sidebooms (583)		2
	50,000 lb excavators		1
	Welding rigs		4
	Tractors/lowboy trailers		1
	Boom trucks		1
	1-ton trucks		1
	Sand pots		1
	185 air compressors		1
	Flocking machines		1
		Foreman	1
		Straw boss	1
		Operators	3
		Welders	4
		Welder helpers	4
		Teamsters	3
		Oilers	3
		Laborers	6
	Buses		1
	Pickups		5

TABLE R-7 (cont'd)

Typical Construction Crews and Equipment Associated with the Capacity Replacement Project

Crew	Equipment	Labor	Quantity
Final cleanup			
	Dozers (D7)		2
	Dozers (D6)		2
	Trackhoes		2
	Tractors/lowboy trailers		1
	Road graders		1
	1-ton trucks		2
		Foreman	1
		Straw boss	1
		Operators	7
		Laborers	13
		Teamsters	3
		Oilers	3
	Buses		1
	Pickups		9

APPENDIX S

DRAFT MITIGATION PLAN FOR
WATERBODY CROSSINGS

Northwest Pipeline Corporation

Mitigation Plan for Waterbody Crossings

Capacity Replacement Project

(Draft)

April 2005

Mitigation Plan for Waterbody Crossings

1.0 INTRODUCTION

Construction of the Capacity Replacement Project will cross 154 waterbodies (55 perennial and 99 intermittent) of which 56 are known or presumed to be inhabited by fish. Project construction will impact 15.73 acres of riparian forest and 30.13 acres of riparian shrub habitat. Most of the riparian impact will occur within Northwest's existing permanent easement and those areas will be restored to riparian shrub habitat upon completion of the project. In addition, many crossing locations do not support desirable riparian vegetation or in-stream characteristics within the existing right-of-way. These areas provide an opportunity to enhance riparian and in-stream habitats. A list of the fish-bearing waterbodies (WDNR Types 1, 2 and 3) traversed by the project is provided in Attachment 1.

In the past four years, Northwest, in consultation with Federal, state and local agencies began improving stream conditions at several pipeline crossings by adding gravel to the streambed, installing large woody debris (LWD), replacing old culverts with new ones that meet fish-passage standards, and planting riparian zones and the existing right-of-way with desirable vegetation. During October 2004 and March 2005, staff from the U.S. Army Corps of Engineers and Washington Department of Ecology conducted field visits to representative restored crossings. In November 2004, representatives from the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, Washington Department of Ecology and Washington Department of Fish and Wildlife met in Olympia to review options for riparian (and wetland) mitigation. Agency representatives agreed that stream crossing mitigation for the Capacity Replacement Project should be conducted on-site (within the right-of-way and temporary workspace). Therefore, Northwest has prepared this plan to incorporate the enhancement measures agreed upon at the November meeting.

2.0 WETLAND AND WATERBODY MITIGATION

Northwest will reduce or eliminate potential impacts to most aquatic resources first through impact avoidance, then minimization and then habitat restoration and enhancement. Northwest will comply with a number of regulatory requirements/programs designed specifically to protect aquatic resources. For example, Northwest will adhere to conditions in Commission's *Wetland and Waterbody Construction and Mitigation Procedures* (Commission's Wetland and Waterbody Procedures) and *Upland Erosion Control, Revegetation and Maintenance Plan* (Commission's Upland Plan) that are specifically designed to avoid or minimize impact to Waterbodies and riparian areas. In addition, conditions of approval, incorporated into the following permits/approvals, will eliminate or reduce most other project-related impacts to fisheries and fish habitat:

1. WDFW Hydraulic Project Approval (HPA) Permit;
2. WDOE 401 Water Quality Certification;
3. U.S. Army Corps of Engineers 404/Section 10 Permit;

4. Conservation measures required by National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) through consultation pursuant to the ESA and EFH; and
5. County Shoreline Substantial Development and Critical Area permits.

2.1 AVOIDANCE AND MINIMIZATION

The project has been designed to avoid impacts to the extent practicable. For example, as an alternative to replacing the entire 268 miles of 26-inch diameter pipeline (as directed by a U.S. Department of Transportation Corrective Action Order) Northwest determined that installation of approximately 79.50 miles of 36-inch-diameter pipeline and 10,760 horsepower (hp) of compression at existing compressor stations will replace the required delivery capacity of the 268 miles of 26-inch pipeline. This design avoids impacts to waterbodies within the remaining 188.5 miles of pipeline corridor affected by the Corrective Action Order. In addition, Northwest proposes to co-locate the loops within Northwest's existing 26-inch mainline and 30-inch loop pipeline corridor. Generally, the centerline of the proposed 36-inch loop pipeline will be installed 20 feet to the east of the existing 30-inch loop and within 15-feet of the eastern edge of Northwest's existing permanent easement. The easement is maintained (periodically mowed to maintain a general herbaceous state) for operational purposes, facilitating corrosion and leak surveys as well as aerial surveillance to prevent building encroachments and third party damages.

Northwest will install the pipeline at the stream crossings in the same locations as the existing pipelines, avoiding the creation of a new crossing location and operational right-of-way except at a few crossings. In addition, Northwest's proposal to work over the existing "hot" or "loaded" pipelines during construction of the project will significantly reduce impacts by minimizing the amount of disturbance outside the existing right-of-way and the need for additional operating right-of-way because the new line will be located, for the most part, within Northwest's existing, maintained permanent easement. Where clearing is required, Northwest proposes to mow or shear woody vegetation so that the roots are left intact. This will facilitate sprouting of shrubs such that the recovery time following construction is minimized. The roots will also help stabilize the soils and stream banks so that erosion is minimized.

Northwest has further reduced potential waterbody impacts by incorporating the measures outlined in the Commission's Wetland and Waterbody Procedures and Upland Plan into the project design. The intent of the Commission's Wetland and Waterbody Procedures is to minimize the extent and duration of project-related disturbance in wetlands and waterbodies. The intent of the Commission's Upland Plan is to confine project-related disturbance to certificated areas (including construction right-of-way, temporary extra workspace and access roads), to minimize erosion, and enhance revegetation in areas affected during construction. The Upland Plan and Wetland and Waterbody Procedures have been developed with the participation of other Federal, state and local agencies, industry, and the public nationwide specifically to mitigate potential impacts from pipeline projects.

To minimize the extent of project-related disturbance, Northwest will verify and clearly mark (with flagging) the construction limits and boundaries of all sensitive areas (including waterbodies and wetlands) prior to clearing for construction. Flagged

boundaries will be maintained during construction. Northwest will ensure that all construction activities are confined to the certified work limits authorized for construction.

Temporary extra workspaces have been located a minimum of 50 feet from the edge of wetlands and waterbodies, where possible, to minimize impacts to wetland buffers and riparian zones as required by the Commission's Wetland and Waterbody Procedures. During construction Northwest will have an Environmental Inspector (EI) present during all phases of construction to ensure compliance with the Upland Plan and Wetland and Waterbody Procedures as well as other project permit stipulations/requirements. Section II A. and B. of the Commission's Upland Plan outlines the responsibility of the EIs.

Northwest's proposed erosion control and revegetation techniques have been developed to minimize erosion and the extent and duration of project-related impacts, as well as to maximize revegetation success. Those techniques are described in the Erosion Control and Revegetation Plan (ECRP) provided in Appendix N of the JARPA application. The ECRP incorporates measures outlined in the Commission's Upland Plan and Wetland and Waterbody Procedures.

Silt fences and/or hay bales will be installed at the edges of the construction right-of-way where there is a possibility for excavated trench spoil to flow into undisturbed areas. Dewatering of the trench will be accomplished in a manner such that no heavily silt-laden water flows into any waterbody. Trench breakers will be installed where necessary to maintain hydrologic integrity. After construction, all disturbed areas will be returned to their preconstruction contours, to the extent practicable, to maintain hydrologic characteristics.

To minimize potential for spills and any impact from such spills, a Spill Prevention, Containment, and Countermeasures (SPCC) Plan has been developed and will be implemented (see Appendix O of the JARPA application). Fueling and storage of hazardous materials will be conducted in accordance with Northwest's SPCC Plan and the Commission's Wetland and Waterbody Procedures.

In addition, impacts will be avoided through compliance with WDFW instream construction timing windows for waterbodies not crossed by the HDDs. Northwest proposes to install the pipeline across non-fish bearing waterbodies within the normal sequence of construction. Timing restrictions for crossing specific fish-bearing waterbodies will follow either the Commission's Wetland and Waterbody Procedures or those of respective permitting agencies. Proposed construction techniques and potential instream construction windows may be subject to change by WDFW in their Hydraulic Project Approval Permit with modifications dictated by conditions in the year of construction. The windows are established to avoid periods of fish use and to construct at lowest flow rates.

Northwest has incorporated three Horizontal Directional Drills (HDDs) into the design of the Capacity Replacement Project to place pipelines beneath waterbodies including: 1) North Fork Nooksack River; 2) North Fork Stillaguamish River; and 3) South Fork Stillaguamish River. These HDDs will avoid project-related impacts to important aquatic resources and avoid affecting 13.28 acres of wetlands and 1.27 acres of riparian forest and shrub vegetation. Additional analyses of wetland impacts that will be avoided by HDD construction are included in Tables 1, 2 and 3 in Appendix F of the JARPA

application. Should one or more of the HDDs prove unsuccessful, Table 4 in Appendix F of the JARPA application provides an analysis of the wetland impacts associated with an alternative crossing method for each of the three waterbodies.

Most streams with fishery values that are not crossed by HDDs will be flumed if water is flowing in the streambed at the time of construction (see Appendix H in the JARPA application). A summary of key flume technique elements includes:

- A flume pipe (or pipes) is placed on the bottom of the waterbody and aligned with the flow of the stream. The size of the flume pipe and the number of pipes to be used is determined by the amount of flow in the particular waterbody. The flume pipe is longer than the construction area of the crossing.
- A temporary dam of sandbags and plastic is constructed at the upstream end of the flume, resulting in the entire stream flow passing through the flume and bypassing the construction area. This allows continuous stream flow to downstream reaches.
- A similar temporary dam of sandbags and plastic is constructed at the downstream end of the flume. This prevents the water in the stream from backflowing into the construction area.
- All in-stream excavation is done between the dams. The dams prevent turbid water created by construction from flowing downstream.
- Adequate flow rates will be maintained.
- Temporary spoil placement will be at least 10 feet from the waterbody and will be contained by sediment barriers.
- Clean gravel or cobbles will be placed in the upper one-foot of trench backfill using specifications provided by the WDFW; and
- All banks will be stabilized and temporary sediment barriers will be installed within 24 hours of completing the crossing.

Flumes will be completely installed and functioning prior to any in-stream disturbance. All flumed crossings will be completed as a single effort to minimize the time of in-stream disturbance. The instream activities associated with placing the flume pipe and constructing the sandbag dams are expected to displace most fish either upstream or downstream from the dams. Once stream flow is diverted through the flume pipe, but prior to pipeline trenching, any fish trapped in any water remaining in the work area between the dams will be removed and released downstream. Northwest will contract with either WDFW or a qualified consultant to capture fish. WDFW will be notified of salvage efforts before fieldwork so that they can be onsite to review or assist in fish capture and transport as they determine necessary.

Seines and dip nets will be used to collect fish; electroshocking equipment will be available for use in deep pools where seines or nets fail to capture all the fish. Captured fish will be transported to the lower dam and released downstream from the flume. Since the flume will maintain stream flow, fish may move upstream through the flume. Flumes will be removed as soon as possible following backfilling of the trench.

Northwest proposes to install the pipeline across non-fish bearing waterbodies within the normal sequence of construction. Timing restrictions for crossing specific fish-bearing waterbodies will comply with WDFW's instream construction timing windows. Proposed

construction techniques and potential in-stream construction windows are provided in Table 4 of the JARPA application.

2.2 IMPACT MITIGATION/RECTIFICATION

Waterbody impacts from the Capacity Replacement Project will include the physical removal of riparian vegetation, disturbance to the stream channel, and suspension of sediments (turbidity) all occurring during pipeline installation. Pipeline operation does not result in additional impacts. Avoidance and minimization of these impacts have been extensively incorporated into the design of the Capacity Replacement Project as described above. Therefore, this plan is designed to specifically mitigate for unavoidable impacts to the three main waterbody features (i.e., riparian vegetation, in-stream habitat and turbidity). These unavoidable impacts will be mitigated through a combination of site-specific treatments to restore and enhance riparian and in-stream habitats at the designated crossing location.

2.2.1 Impacts to Riparian Vegetation

The root network of trees and shrubs adjacent to streambanks are essential to maintaining streambank stability (WDNR, 1997). Because root strength decreases significantly at distances beyond one-half the tree crown diameter, trees promoting streambank stability lie within half a tree crown diameter from the streambank. Trees within 25 feet of the streambank are assumed to promote streambank stability (WDNR, 1997). Generally, trees that must be removed during construction will be cut at ground level with the roots left in place, except where located within the trenchline. Although roots will decay overtime, streambank stability will be retained by their presence until revegetation is successful. Shrub areas will be sheared or mowed to facilitate sprouting from existing roots which will shorten the recovery time following construction. The roots will also help hold the soils so that erosion is minimized. A benefit of clearing is that undesirable species such as reed canary grass and blackberry will be removed. The U.S. Army Corps of Engineers has indicated that their recommended seed mix has been shown to minimize the re-establishment of reed canary grass. The removal of blackberry thickets will provide an opportunity for desirable species to become established. This will be enhanced during the maintenance and monitoring schedule.

After completion of construction and during final clean-up, pre-construction topographic conditions and contours of uplands, wetlands and streambeds will be restored to reestablish drainage patterns and wetland hydrology. Any excess backfill will be spread over upland areas and stabilized during cleanup. Where the pipeline trench intersects a waterbody, Northwest will install trench breakers and/or seal the trench bottom as necessary to maintain the original wetland hydrology. A permanent slope breaker and a trench breaker will be installed at the base of slopes near boundaries between the waterbody and adjacent upland area. The trench breaker will be located immediately upslope of the slope breaker.

Once site elevations have been restored, the construction right-of-way and temporary workspace, including the banks, will be revegetated with native woody species and U.S. Army Corps of Engineer's recommended seed mix. A list of proposed woody species and the seed mixes are provided below in Tables 1 and 2. Northwest has retained Natural Recovery, a firm from Vancouver, Washington that specializes in restoration to assess each site and prescribe the appropriate planting regiment in accordance with this plan, at the time of planting.

Table 1. Suggested Native Shrub and Tree Plantings for Riparian Restoration

SHRUBS		Size/Type	Spacing
Wet Ground			
Cornus stolonifera	Red-osier dogwood	36" cuttings	2'
Salix lasiandra (= lucida)	Pacific willow	36" cuttings	2'
Salix sitchensis	Sitka willow	36" cuttings	2'
Moist Ground			
Oemlaria cerasiformis	Indian plum	1 gal	6'
Physocarpus capitatus	Pacific ninebark	1 gal	8'
Sambucus racemosa	Red elderberry	1 gal	8'
Acer circinatum	Vine maple	1 gal	6'
Rubus spectabilis	Salmonberry	1 gal	4'
Rosa pisocarpa	Clustered wild rose	1 gal	6'
Salix scouleriana	Scouler willow	1 gal	8'
Dry Ground			
Symphoricarpos albus	Snowberry	1 gal	4'
Amelanchier alnifolia	Service-berry	1 gal	8'
Holodiscus discolor	Ocean spray	1 gal	8'
Corylus cornuta	Hazelnut	1 gal	8'
TREES		**Size/Type**	**Spacing**
Wet Ground			
Fraxinus latifolia	Oregon ash	1 gal	10'
Picea sitchensis	Sitka spruce	2 gal	15'
Thuja plicata	Western red cedar	2 gal	12'
Populus trichocarpa (balsamifera)	Black cottonwood	1 gal	10'
Populus tremuloides	Quaking aspen	1 gal	10'
Moist Ground			
Rhamnus purshiana	Cascara	1 gal	10'
Thuja plicata	Western red cedar	2 gal	12'
Tsuga heterophylla	Western hemlock	1 gal	12'
Populus trichocarpa (balsamifera)	Black cottonwood	1 gal	10'
Dry Ground			
Pseudotsuga menziesii	Douglas' fir	1 gal	12'
Acer macrophyllum	Big-leaf maple	2 gal	15'

Note: Shrubs will be installed in clusters of 5 to 10, while trees will be individual specimens. Planting densities per unit area will be computed individually for the shrub and tree canopies using the listed average spacings.

With landowner permission, native woody species will be planted across the entire 75-foot permanent easement and within 50 feet of the stream banks or channel migration zones. Where the land use does not support a full 50 feet, Northwest will plant the available space. Species' placement will be correlated to moisture regime requirements based on three categories of wet, moist or dry ground as indicated in Table 1. Faster growing native trees may be placed closest to the bank top to provide the most rapid canopy recovery possible that can shade and overhang the stream. Plantings would conform to the Commission's Wetland and Waterbody Procedures (Appendix C, Section VI.D.1) which advise that trees exceeding 15 feet tall grow no closer than 15 feet to the

pipeline. By revegetating streambanks with riparian species, streambank stability will be enhanced over the long-term and will provide for stream shading, sediment intercept, and input of detrital nutrients to the stream, all of which are key functions of riparian zones (WDNR, 1997). The Commission's Wetland and Waterbody Procedures (Appendix C, Section V.D.1) limit vegetation maintenance adjacent to waterbodies to allow development of a riparian vegetative strip. Herbicides or pesticides will not be used within 100 feet of a wetland during maintenance activities for the life of the project.

Table 2. Wetland Seed Mixtures

Seed Mixture 3a- Seed Mixture for Disturbed Emergent Wetlands for all Loops [1]		
Perennial Grasses		**lbs/ac**
Ryegrass, Annual	*Lolium multiflorum*	20.0
Creeping bentgrass	*Agrostis stolonifera*	0.4
Garrison creeping foxtail	*Alopercurus arundianceus*	3.0
Meadow foxtail	*Alopercurus pratensis*	2.0
Red fescue	*Festuca rubra*	2.0
Hairgrass, Tufted	*Deschampsia caespitosa*	0.5
American sloughgrass [2]	*Beckmannia syzigachne*	2.0
Western Mannagrass	(*Glyceria occidentalis*)	3.0
Total Bulk lb/acre		**32.9**
Seed Mixture 4 - Wetland Seed Mixture for all Loops [1]		
Grasses		**lbs/ac**
Ryegrass, Annual	*Lolium multiflorum*	20
Quick Guard [3]		40
Fescue, Fine or Creeping Red	*Festuca rubra*	5
Hairgrass, Tufted	*Deschampsia caespitosa*	2
Mannagrass, Reed [2]	*Glyceria grandis*	2
Barley, Meadow [2]	*Hordeum Brachyantherum*	5
Foxtail Water [2]	*Aleopecurus geniculatus*	2
Rice Cut-grass [2]	*Leersia oryzoides*	2
Clover, Springbank [2]	*Trifolium wormskjoldii*	2
Total Bulk lbs/acre		**80**

[1] Seed mixture numbers correspond to the Seed Mixtures provided in the ECRP.
[2] These species may be included in the seed mixture if they are readily available from a commercial seed supplier.
[3] Quick Guard is a sterile hybrid of wheat and rye.

2.2.2 Impacts to In-Stream Habitat

The primary impact to in-stream habitats is the temporary removal of gravel substrate and the loss of in-stream structure. In most cases, original pipeline construction removed trees, logs and stumps from the pipeline right-of-way such that a loss of actual structure from the Capacity Replacement Project is limited. To restore and enhance affected in-stream habitat Northwest would install large woody debris (LWD) at appropriate areas in the waterbody and/or stream banks within the construction right-of-way to mitigate for potential short-term impacts that may occur to aquatic species from the crossing and in-stream construction. Placement of LWD, particularly large western red cedars (minimum length of 1.5 times channel width), in the stream in a manner prescribed by WDFW can supply habitat for forage species and enhance the rearing potential of an area (Cederholm et al., 1997; Slaney et al., 1997). Placement of LWD on the banks and in the stream can compensate for loss of shade and diminished bank stability while revegetation is maturing. Placement of LWD would occur during construction of the waterbody crossing while the flume is in place to prevent turbidity

during installation. The LWD would be placed after the pipe has been installed, during trench backfilling, and bank restoration or recontouring. The number of LWD pieces and placement will be determined at the time of the crossing and will be dependent on the available locations within the right-of-way. Waterbody locations where LWD would be installed are listed in Attachment 2 of this Plan. In addition, Northwest will install clean gravel or cobbles in the upper one-foot of trench backfill using specifications provided by the WDFW. Where the project traverses streams with culverts on the right-of-way, Northwest will work with WDFW and the landowner to install new culverts that enhance fish passage and prevent additional loss of in-stream habitats that result from improperly sized culverts.

2.2.3 Impacts from Turbidity

Turbidity impacts have been substantially avoided and minimized through the use of HDD and other dry stream crossing methods; proper best management practices; and, implementation of the Commission's Waterbody and Wetland Procedures and Upland Plan. However, it is not possible to avoid short-term turbidity impacts to Pilchuck Creek and the Nisqually River which are not technically feasible to cross by HDD procedures because of geotechnical as well as physical conditions at these crossings (see Appendix C in the JARPA application – HDD Geotechnical and Feasibility Assessment). In addition, should the proposed HDDs fail, Northwest will be required to install these crossings using the open cut method. Northwest understands the primary concern created by turbidity is the potential downstream effects on spawning habitat as well as effect to other habitats that support essential salmonid behaviors and life stages including breeding, spawning, rearing, migrating, feeding or sheltering (National Marine Fisheries Service, 1999).

The amount of sediment produced by open-cutting depends on multiple characteristics at the construction site including depth and width of the stream (affects mixing of the sediment plume in the water column), current velocity and local turbulence at the site and downstream, concentrations of suspended sediment initially at the site and at some distance downstream, particle diameter, specific weight, and settling velocity of the excavated and backfilled materials (Ritter, 1984; Reid et al., 2004).

Northwest contracted Golder Associates (Golder) to estimate the amount of instream sediment produced and extent of downstream effects of suspended sediments during open-cut construction of the North Fork Nooksack River, North Fork and South Fork Stillaguamish River should proposed HDDs fail, and during proposed open-cut construction of Pilchuck Creek and the Nisqually River (see Attachment 3 for the complete report). The estimates were derived from available water quality data for each waterbody during July and August – the period when instream construction would occur in 2006 (from Washington Department of Ecology monitoring stations), historical stream flow data for the same months (from USGS gauging stations), relative abundance of sediment grain size at each crossing site and stream channel physical dimensions (determined by Golder during on-site geological investigations conducted in 2003), and Northwest's proposed open-cut construction technique.

These data were applied to hydraulic analyses that evaluated maximum total suspended sediment (TSS) concentrations at the site of each open-cut and changes in TSS concentrations (mg/L) downstream of the excavations to distances where TSS concentrations were expected to equal background values. The maximum predicted TSS's resulting from an open cut at the five waterbody crossings falls within natural

occurring TSS ranges resulting from natural flow events based on the available water quality data for the streams. The higher TSS's appear to be related to higher stream flows.

In the North Fork Nooksack River, background TSS concentrations during July and August are expected to be 30 mg/L, maximum TSS concentration during construction at the crossing site is estimated at 84 mg/L which would diminish to background levels at approximately 500 feet downstream.

Similarly, background TSS in Pilchuck Creek at the time of construction was estimated at 3 mg/L, peaking at 84 mg/L during construction at the site while resuming background concentrations 400 feet downstream. Background TSS concentrations in the North Fork and South Fork Stillaguamish River are 5 mg/L. In the North Fork, maximum TSS concentration at the crossing site is estimated at 21 mg/L during construction, reaching background concentrations 590 feet downstream while in the South Fork a peak of 10 mg/L is expected during construction at the crossing site which would return to background levels 525 feet downstream.

Of all waterbodies, the Nisqually River has the lowest background TSS concentration estimated at 2 mg/L during July and August. Peak sediment generation at the crossing site during construction is estimated at 42 mg/L but because of the low estimated background levels, hydraulic modeling estimates that TSS concentrations would return to background levels at approximately 1,250 feet downstream from the open-cut construction site.

The chief benefit of open-cutting is the minimization of the amount of time of instream construction while allowing fish to pass through the construction area (Reid et al., 2004). However, fish abundances downstream of pipeline construction sites have rarely been measured but generally are reported as short-term reductions (Reid and Anderson, 1999). Fish emigrate from construction sites to locations where sediment deposition has not affected habitat suitability (Reid and Anderson, 1999). Fish abundance (brook trout) before and after dam-and-pump construction (a "dry-crossing" construction technique typically generating less turbidity than "wet-crossing" construction) indicated lower abundances of fish downstream (but not upstream) one month after construction. One year after construction, no differences (increased abundance was observed downstream in one stream) were found (Reid et al., 2002).

The five waterbodies which may be open cut are classified as Class A. According to WAC Chapter 173-201A, turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU in Class A waterbodies. To monitor the turbidity levels during construction of the open cut crossings, Northwest proposes to take upstream and downstream turbidity samples every three hours. The upstream sampling location will be just off of the right-of-way. The downstream sampling location will be 300 feet from the downstream edge of the in-stream activity. If the sample shows an increase of more than 5 NTU (10 percent for streams with background over 50 NTU), the sample location will be moved to the point of compliance, immediately outside of the mixing zone, which will be a distance determined by WDOE from the downstream edge of the in-stream activity.

In order to mitigate for unavoidable turbidity impacts Northwest is proposing to participate in projects that specifically target the creation or enhancement of spawning and other requisite habitats for salmonids. Specifically, large woody debris (LWD) with attached root wads and tree-trunk lengths and diameters (dbh) specified by WDFW or other regulatory agencies that are cleared from the construction right-of-way and temporary extra workspaces would be collected, transported, and stockpiled at designated locations. Northwest would donate these logs for use as LWD. This material would be made available to organizations conducting in-stream restoration and enhancement projects within the affected WRIAs. Northwest contacted the Nooksack Tribe, Lummi Nation, Stillaguamish Tribe, Nisqually Tribe, Nooksack Salmon Enhancement Association, Stilly-Snohomish Fisheries Enhancement Task Force, Snohomish County Surface Water Management and King County Department of Natural Resources about the LWD. Each of these organizations expressed a strong interest in the LWD and indicated that the material could readily be utilized in their ongoing restoration/enhancement projects.

For the Sumas Loop, within WRIA 1, Northwest would provide LWD to the Nooksack Tribe. Northwest would haul the LWD to the Tribe's existing storage yard or to a specific project site within WRIA 1 where this material will be utilized.

For the Mt. Vernon Loop, within WRIAs 5 and 7, Northwest would provide LWD to the Stillaguamish Tribe and/or the Stillaguamish Implementation Review Committee (SIRC) who would direct the LWD to priority enhancement projects within the watershed. The LWD would be hauled to a centralized location, such as a storage site at the Tribe's nursery, which the Tribe or other enhancement organizations could access. The LWD may also be hauled to a priority project site, as directed by the SIRC, within the watershed where the material would be utilized.

For the Snohomish Loop, within WRIA 8, Northwest would provide LWD to King County Department of Natural Resources. Northwest would haul this material to one of King County's existing yard locations near the construction right-of-way or to a specific project site within the WRIA where this material would be utilized by the county. Alternatively, Northwest would temporarily store the LWD on the edge of the construction right-of-way at a suitable access location so that the county could haul this material to one of their designated yard or project sites.

Northwest would provide LWD to the Nisqually Tribe for the Ft. Lewis Loop within WRIA 11. This material would be hauled to the Nisqually Tribe's existing storage yard or to a project site near the construction right-of-way.

Prior to construction in 2006 Northwest will coordinate with each of the Tribes/organizations to determine the specific LWD hauling locations. After the construction right-of-way has been staked and Northwest has determined the CRP's in-stream LWD requirements for the project's stream crossings, Northwest will approximate the number of LWD pieces that will be available for donation to each of these organizations. Currently, it is not feasible to quantify the amount of LWD that will be available for donation from each of the project's loops. Without the construction limits being staked and knowing the specific number of LWD pieces that will be installed at each of Northwest's stream crossing (based on site-specific conditions at the time of construction) it is not possible to determine the amount of additional LWD that will be available for donation. In addition, large trees on the edge of the construction right-of-

way are typically not available for LWD because equipment cannot maneuver around the trees to push/pull the trees over with an attached rootwad. Furthermore, pulling trees over along the edge of the right-of-way can leave large holes/depressions on the edge of the right-of-way because of the root spread of the trees. These depressions may require off-right-of-way encroachment to refill/recontour.

Currently, Northwest estimates that approximately 15-20 pieces of LWD would be available to the Tribes/organizations from each of the loops totaling approximately 60-80 pieces of LWD for the project. This habitat material would have a current market value of between $21,000 - $60,000 depending on material size and **not** including hauling costs. However, the cost to Northwest of providing this material is considerably higher considering the labor involved to identify and mark the material for LWD salvage, the additional equipment and labor necessary to push/pull the trees over for LWD salvage and the additional time and equipment needed to sort and haul this material which is atypical from general right-of-way clearing operations. The labor and equipment cost of Northwest's union contractors is also significantly higher than the typical non-unionized logging industry rates.

3.0 MITIGATION MONITORING

Monitoring of riparian habitats will be conducted annually for three years following construction to determine the mitigation success. In areas where forested or shrub wetlands are being restored, the monitoring period will likely be extended by permit condition to 10 years (Washington State Department of Ecology - WDOE, 2004). Where a 10-year monitoring period is necessary, monitoring would occur in years 1, 2, 3, 5, 7 and 10. If the success criteria are reached prior to completion of the 10-year monitoring period, Northwest would request suspension of the monitoring program. A qualified biologist will conduct monitoring during the growing season by collecting information on plant survival, percent vegetative cover, as well as hydrologic conditions. Photographs will be taken each year to support the monitoring efforts. Reports will be prepared after each monitoring period to document collected data and the reports will be submitted to the appropriate agencies.

Monitoring will also determine if non-native invasive species that were not present prior to construction have become established. Revegetation will be considered successful if native herbaceous and/or woody species' cover is at least 80 percent of the total area and the diversity of native species is at least 50 percent of the diversity originally found in the wetland. Vegetation cover will be estimated (ocular) within a 2.5-meter radius that is representative of the site. All species will be listed by stratum and percent cover for each species. Monitoring will determine if the seeded and installed species have become established.

If revegetation is not successful at the end of three years, a remedial revegetation plan will be developed and implemented (in consultation with a professional wetland ecologist and the U.S. Army Corps of Engineers, WDOE, and local jurisdictions) to actively revegetate with native herbaceous and woody plant species where appropriate. Monitoring will determine if additional monitoring is required or if other measures or contingencies are required to correct any problems (e.g., if weed control of non-native invasive species is necessary to reduce competition or additional plant stock/cuttings should be installed).

Hydrologic conditions will be monitored by visual inspection to determine if the hydrology has been reestablished. Monitoring will note presence of surface water or if groundwater is present in soil pits. Hydrologic indicators will also be noted (*i.e.,* water marks or drift lines, sediment deposits, evidence of ponding, etc.).

4.0 REFERENCES

Cederholm, C. J., L. G. Dominguez, and T. W. Bumstead. 1997. Rehabilitating Stream Channels and Fish Habitat Using Large Woody Debris. Pages 8-1 to 8-28, *in* P.A. Slaney and D. Zaldokas (editors). Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No. 9. British Columbia Watershed Restoration Program, Ministry of Environment, Lands and Parks, and Ministry of Forests. Vancouver, B.C.

Slaney, P. A., R. J. Finnigan, and R. G. Miller. 1997. Accelerating the Recovery of Log-jam Habitats: Large Woody Debris-boulder Complexes. Pages 9-1 to 9-24, in P.A. Slaney and D. Zaldokas (editors). Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No. 9. British Columbia Watershed Restoration Program, Ministry of Environment, Lands and Parks, and Ministry of Forests. Vancouver, B.C.

National Marine Fisheries Service. 1999. Endangered and Threatened Wildlife and Plants; Definition of "Harm". Federal Register 64(215):60727-60731.

National Marine Fisheries Service. 2000. Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California. Federal Register 65(32):7764-7787.

National Marine Fisheries Service. 2003. Proposed Rule: Advance Notice of Proposed Rulemaking to Designate Critical Habitat for 20 Listed Evolutionarily Significant Units of Pacific Salmon and Steelhead. Federal Register 68(188):55926-55932.

Reid, S.M., F. Ade, and S. Metikosh. 2004. Sediment Entrainment During Pipeline Water Crossing Construction: Predictive Models and Crossing Method Comparison. Journal of Environmental Engineering and Science 3:81-88.

Reid, S.M., and P.G. Anderson. 1999. Effects of Sediment Released During Open-cut Pipeline Water Crossings. Canadian Water Resources Journal 24: 23-39.

Reid, S.M., S. Stoklosar, S. Metikosh, and J. Evans. 2002. Effectiveness of Isolated Pipeline Crossing Techniques to Mitigate Sediment Impacts on Brook Trout Streams. Water Quality Research Journal of Canada 37:473-488.

Ritter, P.W. 1984. Water Quality Concerns Associated with Pipeline Stream Crossings. Pages 447-456 in A.E. Crabtree (editor). Proceedings of the Third International Symposium on Environmental Concerns in Rights-of-way Management. Mississippi State University, Mississippi State, MS.

U.S. Fish and Wildlife Service. 2004. Proposed Rule: Proposed Designation of Critical Habitat for the Jarbidge River, Coastal-Puget Sound, and Saint Mary-Belly River Populations of Bull Trout. Federal Register 69(122):35768-35857.

Washington Department of Natural Resources. 1997. Final Habitat Conservation Plan. Washington Department of Natural Resources, Olympia, WA.

Washington Department of Fish and Wildlife and Northwest Indian Fisheries Commission. 2004. Salmon and Steelhead Habitat Inventory and Assessment Program. Online: http://wdfw.wa.gov/hab/sshiap/.

Washington State Department of Ecology. 2004. Draft. Wetlands in Washington State Volume 2: Managing and Protecting Wetlands. Washington State Department of Ecology Publication # 04-06-024.

Attachment 1

Waterbodies Traversed by the Capacity Replacement Project

Attachment 1

WDNR Type 1, 2 and 3 Waterbodies Crossed by the Capacity Replacement Project or Waterbodies within Riparian Zones and Floodplains

Pipeline Loop and Fish-bearing Waterbodies Crossed	Waterbody	MP	WDNR Stream Type	Crossing Method	Riparian Zone Width (feet)	Riparian Vegetation Associated with Waterbody [1]					
						Types in Existing ROW	Area (acres) Present	Types in New ROW	Area (acres) Affected	Types Affected by TEWS&TROW	Area (acres) Affected
Sumas Loop:											
Saar Creek	S-4A and S-4B	1483.10 and 1482.81	1	Dam&Pump	170 and 90	Wetland	0.04	none	0	Wetland	<0.01
Tributary to Lake	S-7	1481.39	3	Flume	140	none	0	none	0	none	0
Kinney Creek	S-21	1479.06	3	Flume	170	Shrub Wetland	0.46 0.41	none	0	Shrub Forest Wetland	0.18 0.16 0.11
Breckenridge Creek	S-22	1478.87	3	Flume	140	Shrub Forest	0.23 0.20	none	0	Shrub Forest	0.55 0.10
Swift Creek	S-23	1477.60	3	Flume	140	Shrub Forest	0.06 0.17	Forest	0.06	Shrub Forest	0.10 0.29
Tributary to Sumas River and Pond Outlet	S-27	1476.80	3	Flume	90	Shrub Wetland	0.02 0.19	none	0	Shrub Wetland	0.02 0.02
Tributaries to Sumas River	S-30 and S-31A, B	1476.16 and 1476.10	5	Flume	170	Shrub Forest Wetland	0.07 0.02 0.06	none	0	Shrub Forest Wetland	0.02 0.05 0.01
Dale Creek	S-32	1475.89	2	Flume	170	Shrub Forest Wetland	0.27 0.05 0.02	none	0	Shrub Forest Wetland	0.02 0.20 <0.01
Tributary to Sumas River	S-47	1473.70	3	Flume	140	Forest	0.56	none	0	Forest	0.30
Smith Creek	S-54	1472.22	3	Flume	140	Forest	0.12	none	0	Forest	0.16
Tributary to Macaulay Creek	S-55	1471.95	3	Flume	140	none	0	none	0	Shrub	<0.01
Macaulay Creek	S-57	1471.04	3	Flume	140	Shrub Forest	0.37 0.11	none	0	Shrub Forest	0.10 0.21
Tributary to Mitchell Creek and Mitchell Creek - ditch	S-57.1 and S-59	1470.85 and 1470.76	3 3	Flume	170 and 90	Shrub Forest Wetland	0.28 0.32 0.31	Shrub Forest	0.03 0.02	Shrub Forest Wetland	0.17 0.01 0.18

Pipeline Loop and Fish-bearing Waterbodies Crossed	Waterbody	MP	WDNR Stream Type	Crossing Method	Riparian Zone Width (feet)	Riparian Vegetation Associated with Waterbody [1]					
						Types in Existing ROW	Area (acres) Present	Types in New ROW	Area (acres) Affected	Types Affected by TEWS&TROW	Area (acres) Affected
Tributaries to Mitchell Creek	S-60 and S-62	1470.14 and 1469.80	3 3	Flume	90	Shrub Forest Wetland	1.38 0.12 0.70	Shrub Wetland	0.01 0.07	Shrub Forest Wetland	0.35 0.59 0.03
Jim Creek, Tributary to Nooksack River North Fork Nooksack River	S-68 S-69 S-70	1468.68 1468.44 1468.20	3(1) 3(1) 1	HDD	140	Shrub Forest	1.58 (0.92)[.2] 0.25 (0.20)[.2]	none	0	Shrub Forest	2.25 2.26
Tributary to South Fork Nooksack River	S-73	1467.41	3	Flume	170	Shrub Forest	0.71 0.01	none	0	Shrub Forest	0.17 0.36
Tributary to South Fork Nooksack River	S-76	1466.81	3	Flume	90	Wetland	0.33	none	0	Wetland	0.09
Tributary to Black Slough Wetland Ditch Tinling Creek Wetland Ditch	S-82 S-82 S-84 S-89A	1465.01 1464.73 1464.60 1463.01	3 3(1) 3(1) 3(1)	Flume	90	Shrub Forest Wetland	5.31 0.18 11.69	Wetland	0.25	Shrub Forest Wetland	0.92 1.03 3.46
Tributary to South Fork Nooksack River	S-91	1461.90	3	Flume	170	Forest Wetland	0.34 0.02	none	0	Forest Wetland	0.22 0.01
Total Riparian Vegetation Affected on Sumas Loop						Shrub Forest Wetland	10.47 (0.92)[.2] 2.69 (0.20)[.2] 13.45	Shrub Forest Wetland	0.08 0.03 0.31	Shrub Forest Wetland	4.84 5.93 3.92
Mt. Vernon Loop:											
Pilchuck Creek	MV-7	1428.60	1	Open Cut	170	Shrub Forest	0.30 0.01	none	0	Shrub Forest Wetland	0.08 0.13 0.12
Armstrong Creek	MV-11	1425.62	2	Flume	170	Shrub Forest	0.98 0.17	none	0	Shrub Forest	0.02 0.61
North Fork Stillaguamish River	MV-14	1424.23	1	HDD	140	none	0	Shrub Forest Wetland	(0.09) [2] (0.09) [2] (0.28) [2]	none	0
South Fork Stillaguamish River and Eagle Creek	MV-15 and MV-16	1423.84 and 1423.49	1 3 (1)	HDD & Flume	140	Shrub Forest Wetland	0.12 0.18 1.22	Shrub Forest Wetland	0.04 0.04 (0.07)[2] 0.41	Shrub Forest Wetland	0.03 0.01 0.32

Pipeline Loop and Fish-bearing Waterbodies Crossed	Waterbody	MP	WDNR Stream Type	Crossing Method	Riparian Zone Width (feet)	Riparian Vegetation Associated with Waterbody [1]					
						Types in Existing ROW	Area (acres) Present	Types in New ROW	Area (acres) Affected	Types Affected by TEWS&TROW	Area (acres) Affected
Tributary to South Fork Stillaguamish River	MV-27	1421.33	3	Flume	170	Shrub Forest	0.75 0.04	Shrub	0.05	Shrub Forest	0.23 0.24
Olson Lake	MV-32A&B	1419.33	2	Push/Pull	170	Shrub Forest Wetland	1.09 0.02 0.89	Shrub Forest Wetland	0.11 0.10 0.33	Shrub Forest Wetland	0.40 0.35 0.18
Star Creek	MV-49.1	1415.32	3	Flume	170	Shrub Forest Wetland	0.83 0.17 0.29	Shrub	0.02	Shrub Forest	0.24 0.07
Tributary to Little Pilchuck Creek	MV-55	1412.12	3	Flume	170	Shrub Forest Wetland	0.75 0.01 0.04	none	0	Shrub Forest Wetland	0.07 0.10 0.05
Little Pilchuck Creek	MV-62 and MV-63	1411.06 and 1410.52	1	Flume	200	Shrub Forest Wetland	0.99 0.42 <0.01	Shrub Forest	0.04 0.01	Shrub Forest	0.46 0.46
Catherine Creek	MV-66	1409.61	1	Flume	170	none	0	none	0	Forest	0.12
Total Riparian Vegetation Affected on Mt. Vernon Loop						Shrub Forest Wetland	5.80 1.02 2.44	Shrub Forest Wetland	0.26 (0.09) [2] 0.15 (0.16) [2] 0.74 (0.28) [2]	Shrub Forest Wetland	1.51 1.82 0.67
Snohomish Loop:											
Tributary to Paradise Lake/Bear Creek	SN-2	1393.77	3	Flume	140	Shrub Forest Wetland	0.35 0.07 0.12	none	0	Shrub Forest Wetland	0.01 0.17 0.01
Tributaries to Paradise Lake/Bear Creek	SN-4 and SN-6	1393.31 and 1393.12	3 3	Flume	140	Shrub Forest Wetland	1.36 0.21 0.83	none	0	Shrub Forest Wetland	0.06 0.20 0.14
Tributary to Paradise Lake/Bear Creek	SN-7	1392.95	3	Flume	140	Shrub Forest Wetland	0.08 0.14 0.17	none	0	Shrub Forest Wetland	0.01 0.10 0.02
Tributary to Paradise Lake/Bear Creek	SN-21	1391.24	3	Flume	140	Shrub Forest Wetland	0.58 0.09 <0.01	none	0	Forest Wetland	0.15 <0.01

Pipeline Loop and Fish-bearing Waterbodies Crossed	Waterbody	MP	WDNR Stream Type	Crossing Method	Riparian Zone Width (feet)	Riparian Vegetation Associated with Waterbody [1]					
						Types in Existing ROW	Area (acres) Present	Types in New ROW	Area (acres) Affected	Types Affected by TEWS&TROW	Area (acres) Affected
Struve Creek	SN-22	1390.20	3	Flume	140	none	0	none	0	Forest	<0.01
Colin Creek	SN-24	1389.40	3	Span	140	Shrub Forest Wetland	0.20 0.01 0.19	none	0	Shrub Forest Wetland	<0.01 0.08 0.05
Tributary to Seidel Creek	SN-28A, B	1388.64	3	Flume	140	Shrub Forest Wetland	0.31 0.03 0.10	none	0	Shrub Forest Wetland	0.11 0.09 0.02
Tributary To Seidel Creek	SN-29	1388.51	3	Flume	140	Shrub Wetland	0.87 0.05	none	0	Shrub Forest Wetland	0.34 0.05 0.02
Evans Creek	SN-42	1383.66	3	Push/Pull	140	Shrub Forest Wetland	0.29 0.12 1.79	none	0	Shrub Forest Wetland	0.03 0.12 0.56
Tributary to Evans Creek	SN-43	1383.41	3	Flume	140	Shrub Forest Wetland	0.84 0.06 0.17	none	0	Shrub Forest Wetland	0.01 0.10 0.03
Total Riparian Vegetation Affected on Snohomish Loop						Shrub Forest Wetland	4.87 0.74 3.41	none	0	Shrub Forest Wetland	0.56 1.06 0.84
Ft. Lewis Loop:											
Muck Creek	FL-12	1332.37	2	Flume	140	Shrub Forest Wetland	0.02 0.04 0.05	Shrub Forest Wetland	<0.01 0.01 <0.01	Shrub Forest Wetland	0.01 0.04 0.01
South Creek	FL-13	1332.11	2	Flume	90	Shrub Wetland	<0.01 0.19	Shrub Wetland	<0.01 0.02	Shrub Wetland	<0.01 0.03
Lacamas Creek	FL-17	1328.71	3	Flume	140	Wetland	0.18	none	0	Wetland	0.26
Murray Creek	FL-23	1327.96	3	Flume	170	Shrub Forest Wetland	0.88 0.05 0.21	none	0	Shrub Forest Wetland	0.50 0.21 0.12

Pipeline Loop and Fish-bearing Waterbodies Crossed	Waterbody	MP	WDNR Stream Type	Crossing Method	Riparian Zone Width (feet)	Riparian Vegetation Associated with Waterbody [1]					
						Types in Existing ROW	Area (acres) Present	Types in New ROW	Area (acres) Affected	Types Affected by TEWS&TROW	Area (acres) Affected
Nisqually River and Centralia Canal	FL-35A,B and FL-37	1324.29 and 1323.85	1 3	Open Cut & Span	170	Shrub Forest Wetland	0.49 0.34 0.15	Shrub Forest Wetland	0.04 0.14 <0.01	Shrub Forest Wetland	0.08 1.24 0.09
Total Riparian Vegetation Affected on Ft. Lewis Loop						Shrub Forest Wetland	1.39 0.43 0.78	Shrub Forest Wetland	0.14 0.04 0.02	Shrub Forest Wetland	0.28 1.78 0.42
Portland Lateral Takeoff											
Tributary to East Fork Lewis River	RF-1	1232.52	3	Flume	140	none	0	none	0	none	0

[1] Only riparian vegetation providing some function is included. Vegetation dominated by grassland, agriculture, residential, urban/industrial sites is omitted.
[2] Vegetation types with areas affected in parenthesis are within the new right-of-way but the areas are not affected since the pipeline will be constructed by HDD.

Attachment 2

Waterbody Locations where LWD would be Installed

Attachment 2
Waterbody Mitigation Treatments

Wetland Number [1]	Milepost[2]	Cowardin Classification [3]	Wetland Seed Mixture [7]	Woody Species Plantings [8]	Planting Location [9]	Large Woody Debris Placement [10]	Streambed Gravel [11]
Sumas Loop (Whatcom County)							
Wetland S-4A, B (Saar Creek)	1483.10	R PEM	3a	Yes	Stream banks	Yes	Yes
Wetland S-7 [4] (Trib. to Lake)	1481.39	R	3a	Yes	Stream banks	Yes	Yes
Wetland S-21 (Kinney Creek)	1479.06	PEM R PSS PFO	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-22 (Breckenridge Creek)	1478.87	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-23 (Swift Creek)	1477.60	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-27 (Trib to Sumas River)	1476.80	PEM R PFO POW	3a	Yes	Stream banks	Yes	Yes
Wetland S-30 (Trib. to Sumas River	1476.16	PSS PFO R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-31 A,B (Trib to Sumas River	1476.10	PEM R PFO	3a	Yes	Stream banks	Yes	Yes
Wetland S-32 (Dale Creek)	1475.86	R PEM	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-47 (Trib. to Sumas River)	1473.70	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-54 (Smith Creek)	1472.23	R	3a	Yes	Stream banks	Yes	Yes
Wetland S-55 (Trib. to Macaulay Creek)	1471.95	R	3a	Yes	Stream banks	Yes	Yes
Wetland S-57 (Trib. to Macaulay)	1471.04	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-57.1 (Trib. to Macaulay)	1470.85	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-59 (Mitchell Creek-ditch	1470.76	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-60 [4] (Trib. to Mitchell Creek)	1470.14	PEM	3a	Yes	Stream banks	N/A	N/A

Wetland Number [1]	Milepost[2]	Cowardin Classification [3]	Wetland Seed Mixture [7]	Woody Species Plantings [8]	Planting Location [9]	Large Woody Debris Placement [10]	Streambed Gravel [11]
Wetland S-62 (Trib. to Mitchell Creek)	1469.79	R	3a	Yes	Stream banks and riparian buffers	N/A	N/A
Wetland S-68 [6] (Jim Creek)	1468.68	R	N/A	N/A	N/A	N/A	N/A
Wetland S-69 [6] (Trib. to Nooksack)	1468.44	R	N/A	N/A	N/A	N/A	N/A
Wetland S-70 [6] (N. Fork Nooksack River)	1468.20	R	N/A	N/A	N/A	N/A	N/A
Wetland -S-73 (Trib. to S. Fork Nooksack River)	1467.41	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-76 (Trib. to S. Fork Nooksack River)	1466.81	PFO PSS PEM R	3a	Yes-in forested temporary right-of-way areas	Wetland	None	None
Wetland S-82 [4] (Trib. to Black Slough & Ditch)	1465.38	PEM	3a	Yes	Stream banks and riparian buffers & Temporary extra work spaces and right-of-way	Yes	Yes
Wetland S-84 [4] (Tinling Creek)	1464.59	R	3a	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland S-89A,B (Ditches)	1463.01 1463.00	PEM	3a	None	Wetland	None	Yes
Wetland S-91 (Trib. to S. Fork Nooksack River)	1461.9	R PEM PFO PSS	4	Yes	Stream banks and riparian buffers	Yes	Yes
Mt. Vernon Loop (Snohomish County)							
Wetland MV-7 (Pilchuck Creek)	1428.62	R	3a	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-11 (Armstrong Creek)	1425.62	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-14 [6] (N. Fork Stillaguamish River)	1424.26	R	N/A	N/A	N/A	N/A	N/A
Wetland MV-15 [6] (S. Fork Stillaguamish River)	1423.84	R	N/A	N/A	N/A	N/A	N/A
Wetland MV-16 [4] (Eagle Creek)	1423.46	PEM POW R	3a	Yes	Stream banks	Yes	Yes

Wetland Number [1]	Milepost[2]	Cowardin Classification [3]	Wetland Seed Mixture [7]	Woody Species Plantings [8]	Planting Location [9]	Large Woody Debris Placement [10]	Streambed Gravel [11]
Wetland MV-27 (Trib. to S. Fork Stillaguamish)	1421.33	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-32A,B (Olson Lake)	1419.33	PSS PEM PFO	4	Yes	Wetland and buffers and in forested temporary workspaces and right -of-way areas	Yes	None
Wetland MV-49.1 (Trib. to Star Creek)	1415.31	R PEM	3	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-55 (Trib. to Little Pilchuck Creek)	1412.12	PEM R PFO PAB	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-62 (Little Pilchuck Creek)	1411.06	R	3	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-63 (Little Pilchuck Creek)	1410.52	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland MV-66 (Catherine Creek)	1409.59	R	3	Yes	Streambanks and riparian buffers	Yes	Yes
Snohomish Loop (Snohomish County)							
Wetland SN-2 (Trib. to Paradise Lake/Bear Creek)	1393.77	PFO PEM R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-4 (Trib. to Paradise Lake/Bear Creek)	1393.32	R PFO PSS PEM	3a	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-6 [4] (Trib. to Paradise Lake/Bear Creek)	1393.11	PFO R PSS PEM POW	3a	Yes	Stream banks and riparian buffers	Yes	Yes
Snohomish Loop (King County)							
Wetland SN-6 [4] (Trib. to Paradise Lake/Bear Creek)	1393.07	PEM PSS PFO R POW	3a	Yes	Stream banks and riparian buffers	Yes	Yes

Wetland Number [1]	Milepost[2]	Cowardin Classification [3]	Wetland Seed Mixture [7]	Woody Species Plantings [8]	Planting Location [9]	Large Woody Debris Placement [10]	Streambed Gravel [11]
Wetland SN-7 (Trib. to Paradise Lake/Bear Creek)	1392.95	PEM PSS PFO R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-21 (Trib. to Paradise Lake/Bear Creek)	1391.24	PSS R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-22 (Struve Creek)	1390.15	R	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-24 (Colin Creek)	1389.40	R PFO PSS	4	Yes	Stream banks and riparian buffers	N/A (Span)	None (Span)
Snohomish Loop (City of Redmond)							
Wetland SN-28 A&B (Trib. to Seidel Creek)	1388.64	R PEM PSS PFO	4	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland SN-29 (Trib. to Seidel Creek)	1388.51	R PSS PFO	4	Yes	Stream banks and riparian buffers	Yes	Yes
Snohomish Loop (King County)							
Wetland SN-42 (Evans Creek)	1383.66	PSS PFO PEM POW	4	Yes	Wetland Banks and buffers	Yes	N/A
Wetland SN-43 (Trib. to Evans Creek)	1383.41	PSS PEM R PFO	4	Yes	Stream banks and riparian buffers	Yes	Yes
Snohomish County (City of Sammamish)							
Wetland SN-43 (Trib. to Evans Creek)	1383.41	PSS PEM	4	Yes	Stream banks and riparian buffers	Yes	Yes
Ft Lewis Loop (Ft. Lewis Military Reservation							
Wetland FL-12 (Muck Creek)	1332.35	R PEM	See ECRP for seed mixture (Section 7.9)	Yes	Stream banks and riparian buffers	Yes	Yes
Wetland FL-13 (South Creek)	1332.11	R PEM PFO	See ECRP for seed mixture (Section 7.9)	Yes	Stream banks and riparian buffers	Yes	Yes
Ft Lewis Loop (Pierce County)							
Wetland FL-17 (Lacamas Creek))	1328.71	R PEM	3A	Yes	Stream banks	Yes	Yes

Wetland Number [1]	Milepost[2]	Cowardin Classification [3]	Wetland Seed Mixture [7]	Woody Species Plantings [8]	Planting Location [9]	Large Woody Debris Placement [10]	Streambed Gravel [11]
Wetland FL-23 (Murray Creek)	1327.92	PFO PEM PSS R	3a	Yes	Streambanks and riparian buffers	Yes	Yes
Wetland FL-35A (Nisqually River)	1324.28	R	4	Yes	Stream banks and riparian areas affected by FL-TEWS -58 &59 and temporary right-of-way	Yes	Yes
Ft. Lewis Loop (Thurston County)							
Wetland FL-35B (Nisqually River)	1324.28	R	4	Yes	Stream banks	Yes	Yes
RETIREMENT OF 26-INCH FACILITIES							
Portland Lateral Take-Off (Clark County) Wetland RF-1	1232.53	R	3a	None	N/A	None	N/A

[1] Wetland numbers correspond to the wetland numbers shown on the Environmental Alignment Sheets.
[2] Approximate milepost is at the center of the wetland perpendicular to the pipeline.
[3] Wetland types according to Cowardin *et al.* (1979).
Palustrine Forested (PFO)
Palustrine Scrub-Shrub (PSS)
Palustrine Emergent (PEM)
Palustrine Open Water (POW)
Palustrine Aquatic Bed (PAB)
Riverine (R)
Lacustrine (L)
[4] Farmed Wetlands-COE Jurisdictional.
[5] Impacts to these wetlands are avoided, but they have been included if they are within 100 feet of the project work area as required by county ordinances.
[6] Impacts to this wetland/stream are avoided by HDD.
[7] See Table 2 for seed mixture specifications. The EI may substitute either of the wetland seed mixtures at individual wetland sites based on site specific conditions and the intent of these mixtures (i.e., Seed Mixture 3a is intended for disturbed emergent wetlands dominated by invasive species and Seed Mixture 4 is intended for wetlands dominated by native species). The landowner may specify alternate seed mixtures.
[8] See Table 1 for the suggested woody species plantings based on site moisture regime. Species to be planted will be determined at the time of planting based on site specific conditions and available planting locations.
[9] Planting locations of woody species will be coordinated with landowners based on existing land use conditions (i.e., agricultural areas).
[10] Placement of in-stream LWD will occur during the crossing when the flume or dam and pump is in place. The configuration and number of LWD will be dependent on available placement opportunities and determined by the EI. LWD will consist of conifers (preferably cedar) with root wads attached, and the size will be appropriate for the stream.
[11] The top 12-inches of the trench will be backfilled with clean spawning gravel with gradations specified by WDFW. Gravel may be utilized during trench backfilling at other stream crossings, as determined by the EI to minimize turbidity or to enhance habitat based on site-specific conditions.

Attachment 3

Determination of Downstream Changes in Water Quality Due to In-Stream Trenching in the North Fork Nooksack River, Pilchuck Creek, North Fork Stillaguamish River, South Fork Stillaguamish River, and Nisqually River

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April 18, 2005

Our Ref.: 043-1116-007-000

Williams – Northwest Pipelines
295 Chipeta Way
Salt Lake City, Utah 84108

Attention: Ms. Lauri Duncombe

Williams – Northwest Pipelines
2800 Post Oak Boulevard
Houston, Texas 77056

Attention: Ms. Suzanne Hickham

RE: CAPACITY REPLACEMENT PROJECT
DETERMINATION OF DOWNSTREAM CHANGES IN WATER QUALITY DUE TO IN-STREAM TRENCHING IN THE NORTH FORK NOOKSACK RIVER, PILCHUCK CREEK, NORTH FORK STILLAGUAMISH RIVER, SOUTH FORK STILLAGUAMISH RIVER, AND NISQUALLY RIVER

Dear Lauri and Suzanne:

The following summarizes the results of our assessment of changes in downstream water quality due to open-cut excavations across the North Fork Nooksack River, Pilchuck Creek, North Fork Stillaguamish River, South Fork Stillaguamish River, and Nisqually River, as outlined in our scope of work (email transmission dated 4/1/05).

The following data were used in the assessment; no site specific flow or channel sediment samples were collected:

- Hydrology - Historical USGS stream flow data were used to determine typical low-flow values during the month of July at each pipeline crossing location. USGS gauging stations are located very near the pipeline crossings at Pilchuck Creek and the Nisqually River. USGS gauging stations at the North Fork Nooksack, North Fork Stillaquamish, and South Fork Stillaquamish sites are located at other locations in the basins. Flow values at these sites were approximated by scaling contributing basin areas from the USGS gauging locations to the crossing sites.

- Site Characteristics – Crossing widths were determined from drawings provided by Williams – Northwest Pipeline (NWP). Geologic investigations completed by Golder for the proposed horizontal directional drill crossings were used to approximate channel bed material types and sediment grain-size distributions. Water quality data were obtained from available Washington State Department of Ecology (WSDOE) monitoring stations to develop background values for Total Suspended Sediment (TSS). The data are shown in Figures 1 through 6. TSS is reported in units of mg/L. WSDOE monitoring stations were located throughout each basin but were typically not located near the pipeline crossings.

- Construction Activities – Crossing procedures were based on the "Waterbody Crossing Methodology Plan, Capacity Replacement Project, November, 2004", provide by NWP. We assumed a generally trapezoidal trench section for the open-cut excavation across the channel with a depth of approximately 10 to 13 feet below the bottom of the channel. We also assumed the work would be completed using an excavator with a bucket with an approximate two cubic yard capacity.

We completed a hydraulic analysis that evaluated changes in TSS concentrations downstream of an open-cut excavation. The analysis determined the maximum TSS as a result of the in-channel work and the distance downstream of the in-channel excavation where TSS concentrations return to background values. The results are presented for each crossing in the attached table. As shown in Table 1 and Figures 1 through 6, the maximum predicted TSS's for the in-channel work at the 5 stream crossing, all fall within the measured range of TSS based on the limited available water quality data for the streams. The measured TSS's appeared to be related to stream flows with the higher TSS's corresponding to high flows. These results are based on available data as outlined above.

We appreciate our continued involvement with the Capacity Replacement Project. If you have any questions or need additional information please call.

Sincerely,

GOLDER ASSOCIATES INC.

Andreas Q. Kammereck, P.E.
Senior Engineer

Clifford C. Knitter, L.E.G.
Principal, Pipeline Services

AQK/CCK/ngs

TABLE

River Crossing	Est. Channel Width (ft), (1)	Est. Channel flow, Q (cfs), (1)	Est. Flow Depth (ft), (1)	TSS Background (mg/L), (2)	Sediment Grain Size (d50), (mm),(4)	Sediment Distribution (%), (5)			Peak estimated TSS (mg/L)	Return to Background TSS (ft), (6)
						silt/clay	sand	coarse		
NF Nooksack	120	500	1.5	30	10	5	35	60	**~84**	**~ 500**
Pilchuck	75	62	0.5	n/a (3)	10	5	35	60	**~85**	**~ 400**
NF Stillaguamish	230	934	2	5	1	20	60	20	**~21**	**~ 590**
SF Stillaguamish	230	1,280	2	5	1	15	35	50	**~10**	**~ 525**
Nisqually	160	572	2	2	10	5	35	60	**~42**	**~ 1,250**

Notes:

(1) Values estimated from available information.
(2) Water quality data from nearest available WSDOE monitoring sites.
Units shown as Total Suspended Solids (TSS) in mg/L concentrations.
(3) No water quality data were available, assumed backgournd TSS was zero.
(4) Assumed material excavated from open-cut trench across channel - d50 is the median sediment grain size in mm.
(5) Assumed downstream mobilized sediment distribution.
(6) Distance downstream from open-cut excavation.

TABLE **1**

SUMMARY OF DOWNSTREAM CHANGES IN TSS AS A RESULT OF OPEN-CUT CROSSING

NWP/STREAM SEDIMENT INVESTIGATION/WA

FIGURES

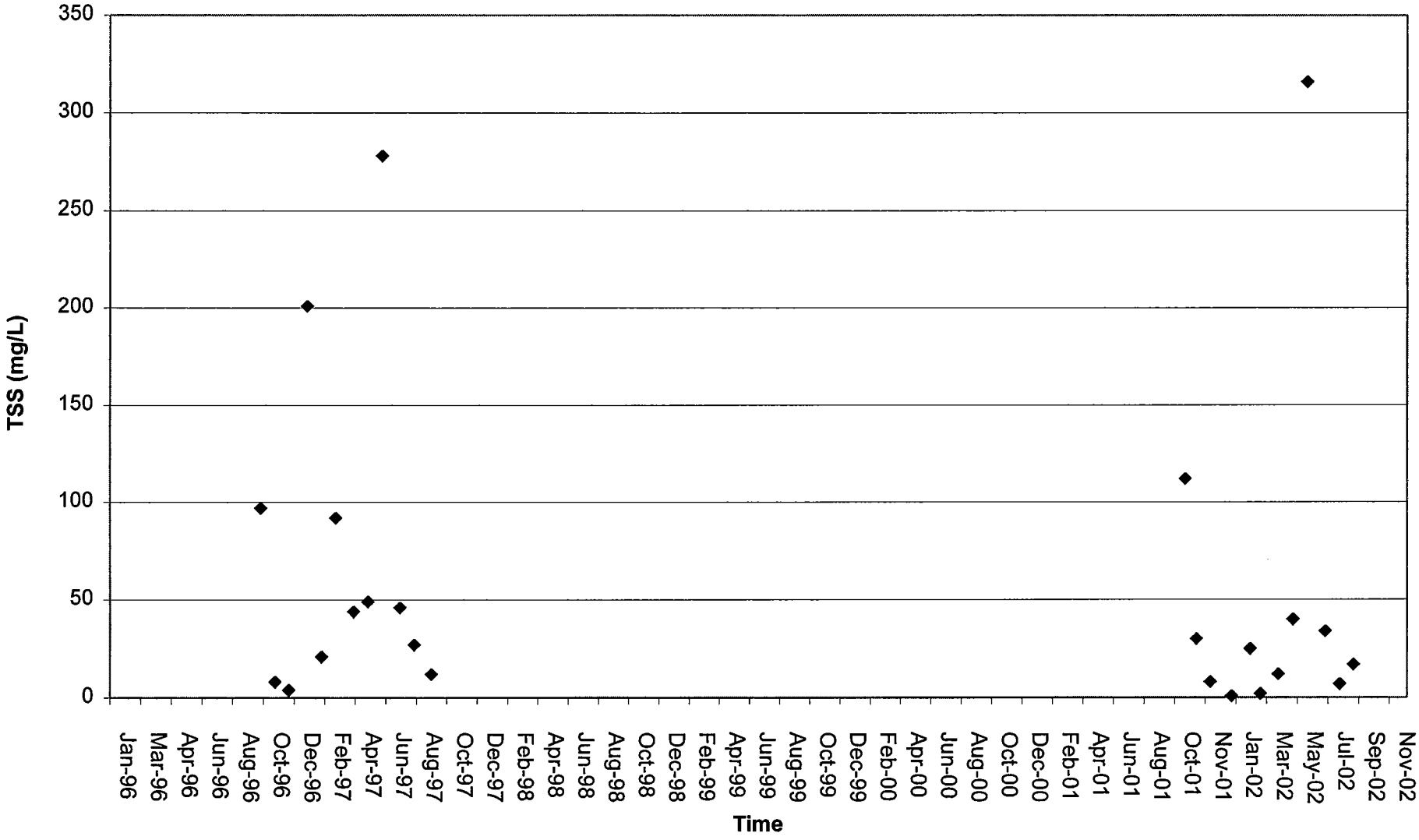

FIGURE 1
NOOKSACK RIVER ABOVE MF
WSDOE, STATION No. 01A140
NWP/STREAM SEDIMENT INVESTIGATION/WA

0431116007000fg02.fh11 | Mod: 04/18/05 | EL

Golder Associates

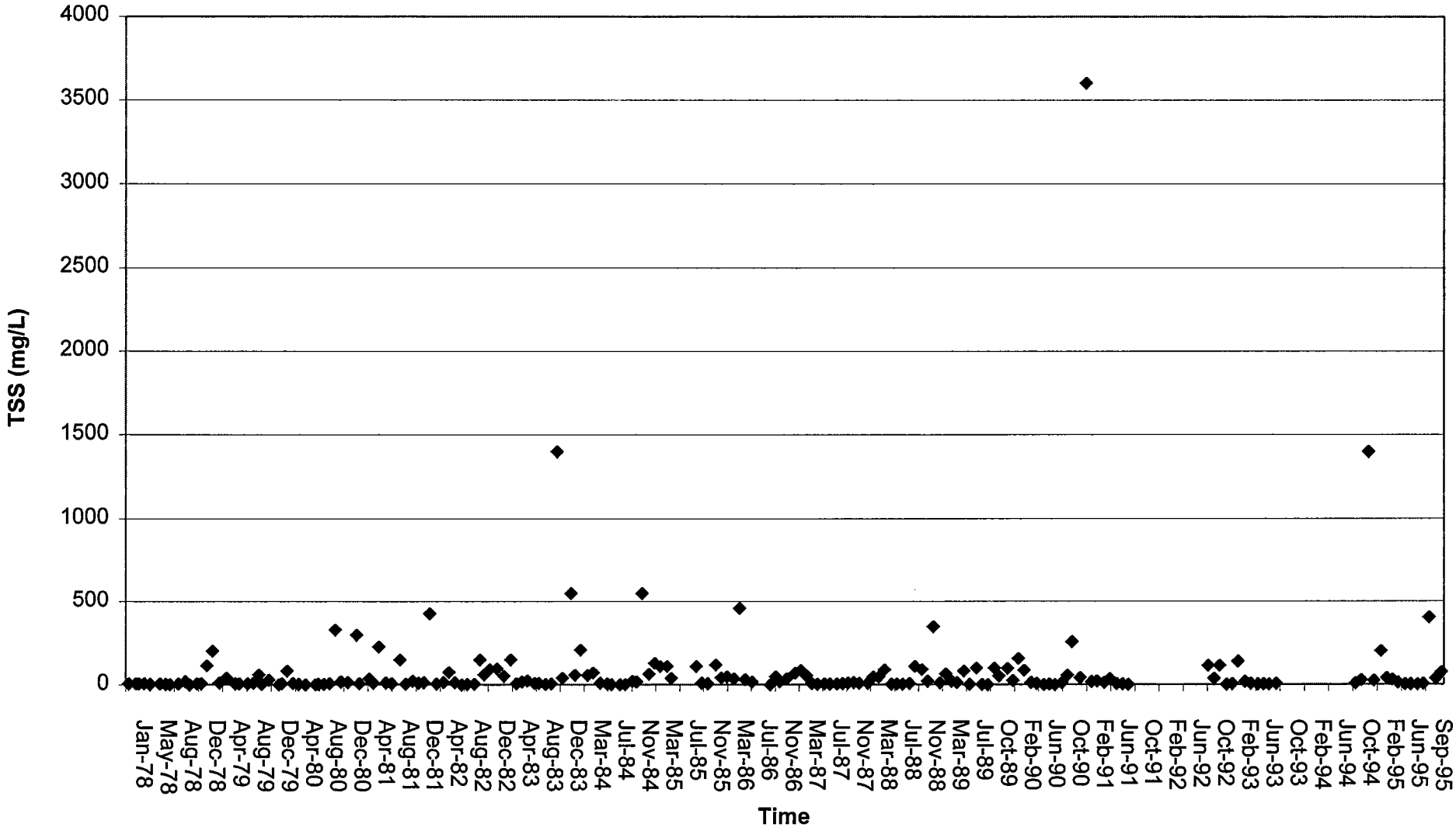

FIGURE **2**

NF STILLAQUAMISH AT CICERO
WSDOE, STATION No. 05B070 (FULL RANGE OF MEASURED TSS)

NWP/STREAM SEDIMENT INVESTIGATION/WA

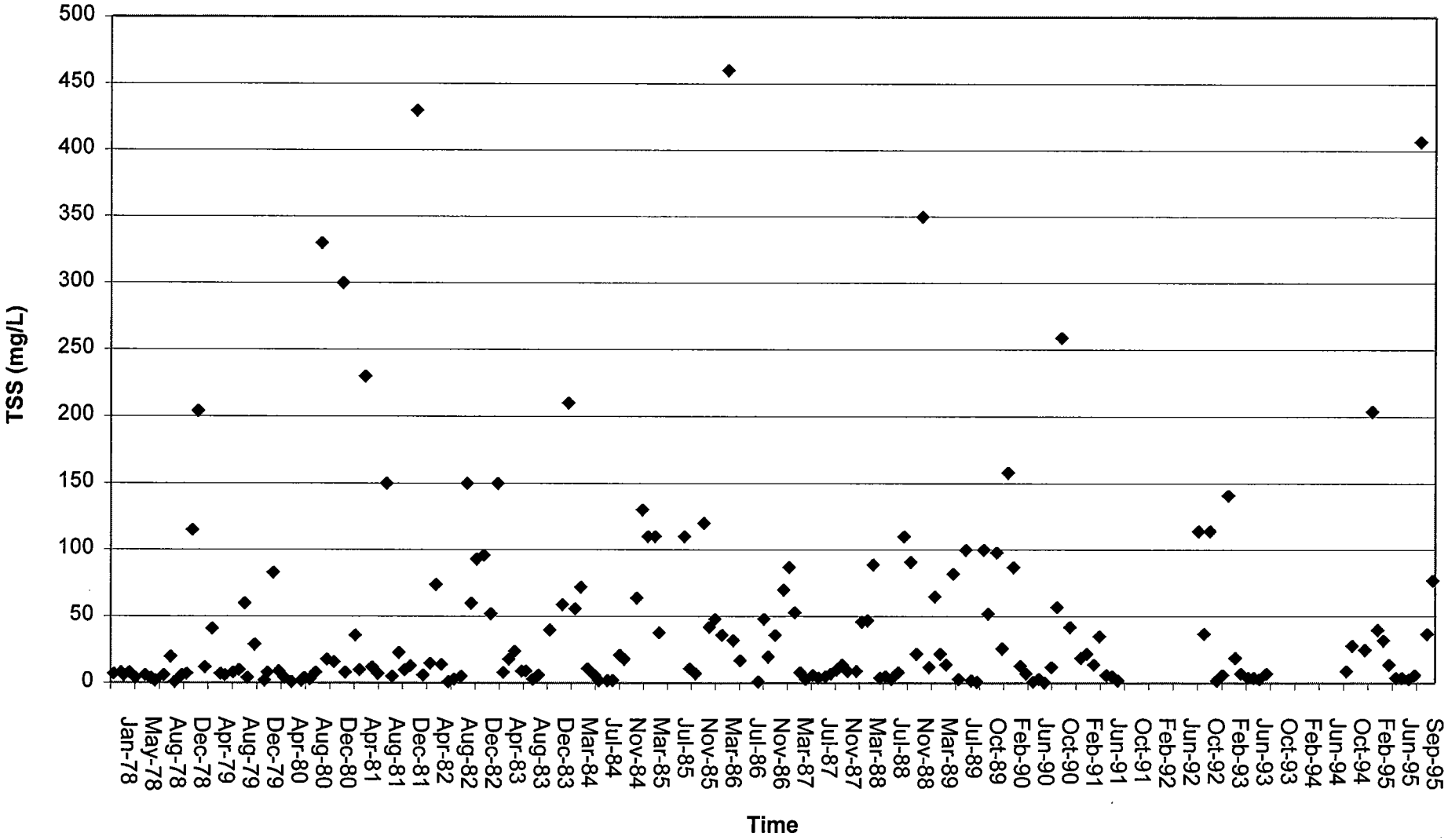

FIGURE **3**

NF STILLAQUAMISH AT CICERO
WSDOE, STATION No. 05B070 (LIMITED TO <500mg/L MEASURED TSS)

NWP/STREAM SEDIMENT INVESTIGATION/WA

0431116007000fg04.fh11 | Mod: 04/18/05 | EL

Golder Associates

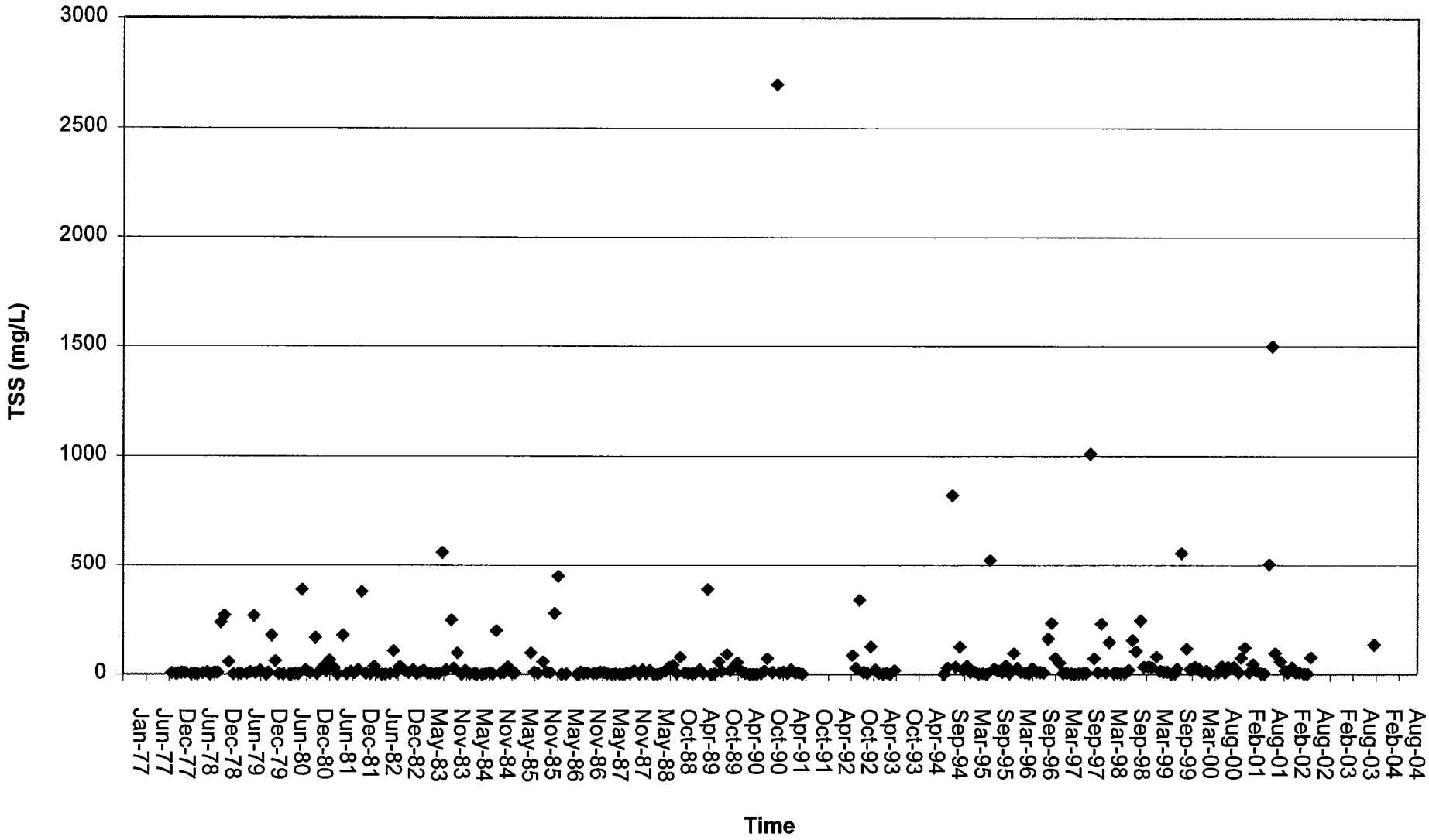

FIGURE **4**

SF STILLAQUAMISH AT ARLINGTON
WSDOE, STATION No. 05A090 (FULL RANGE OF MEASURED TSS)

NWP/STREAM SEDIMENT INVESTIGATION/WA

0431116007000fg05.fh11 | Mod: 04/18/05 | EL

Golder Associates

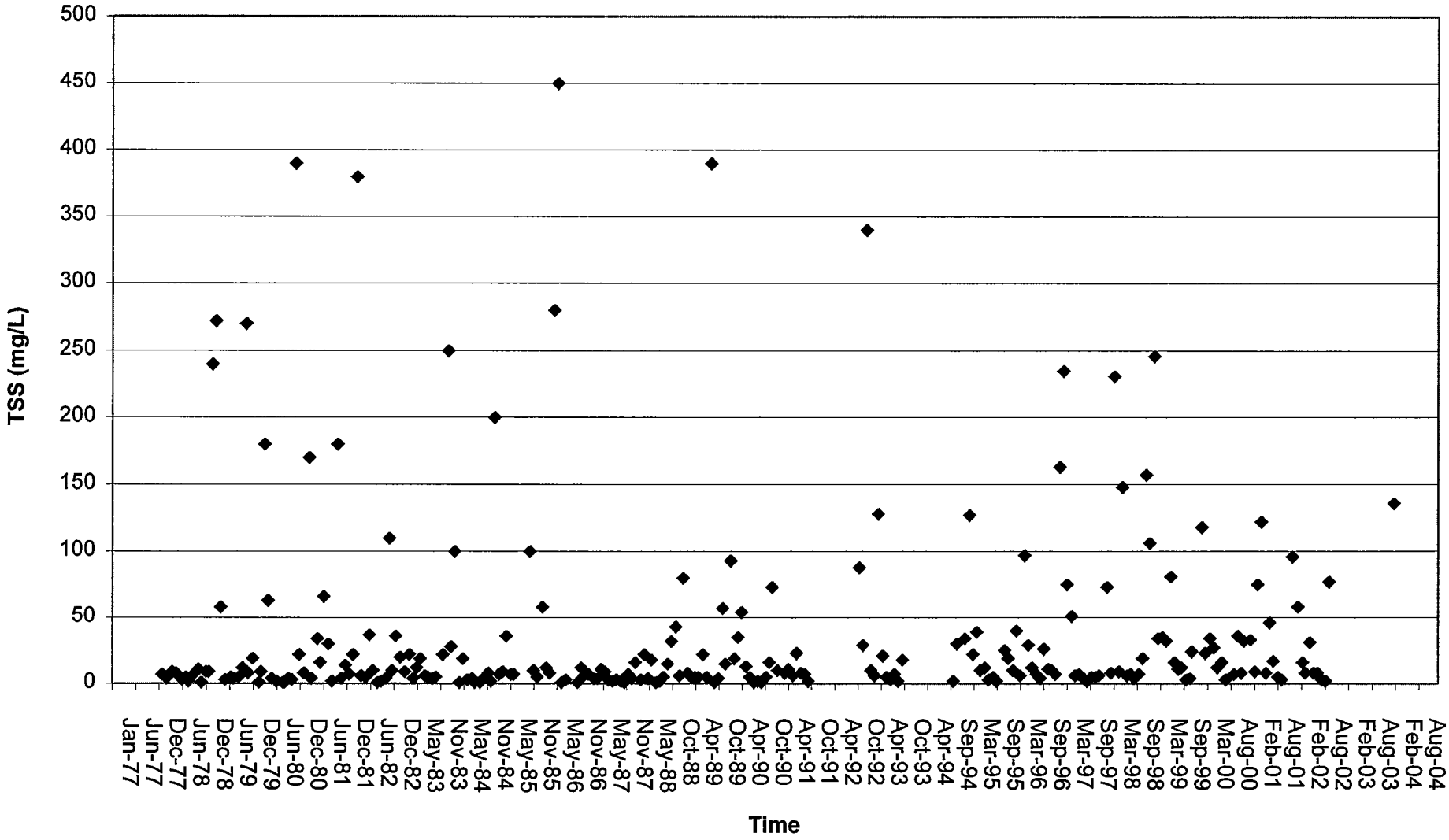

FIGURE **5**

SF STILLAQUAMISH AT ARLINGTON
WSDOE, STATION No. 05A090 (LIMITED TO <500mg/L MEASURED TSS)
NWP/STREAM SEDIMENT INVESTIGATION/WA

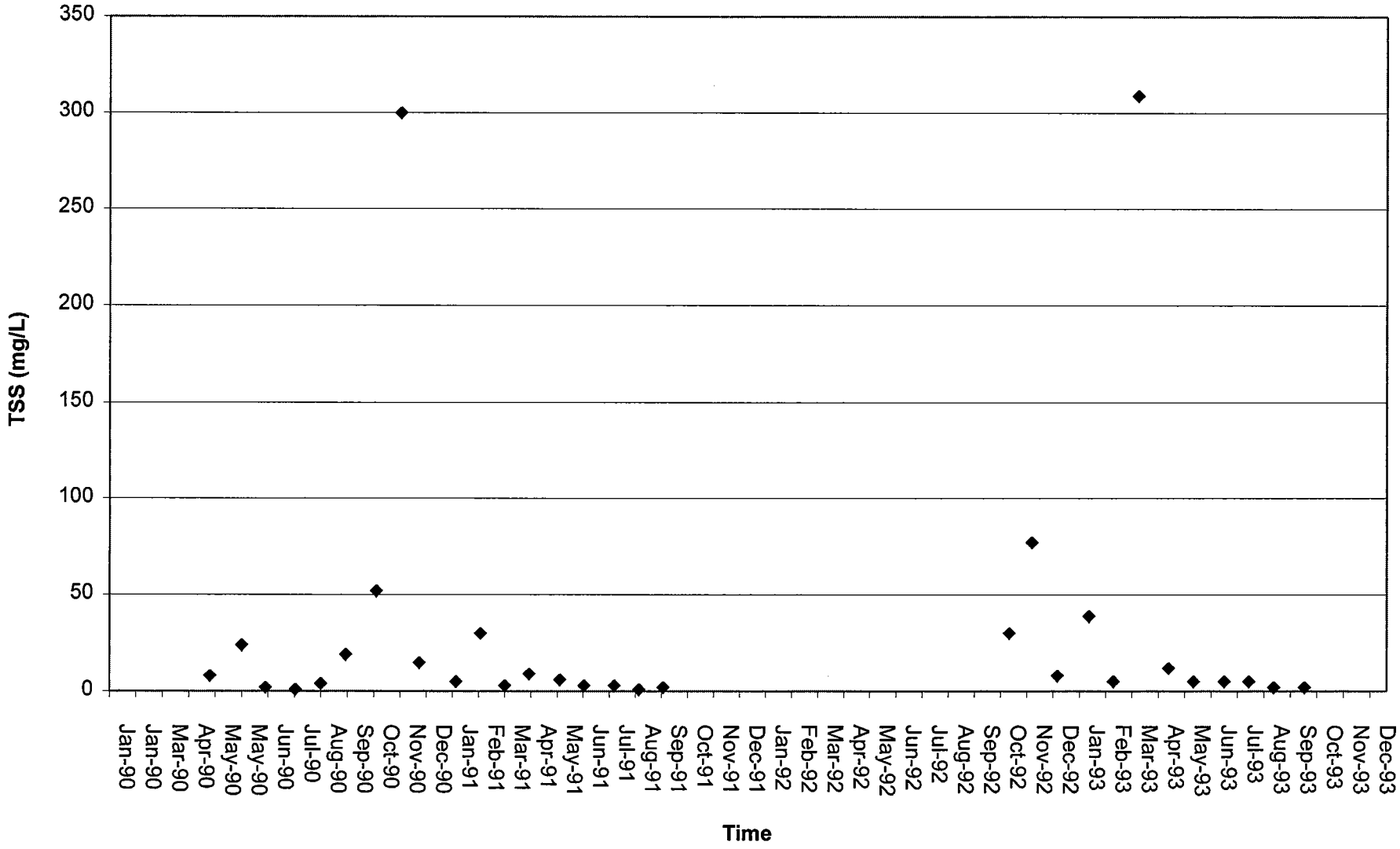

FIGURE **6**

NISQUALLY RIVER AT MCKENNA
WSDOE, STATION No. 011A080
NWP/STREAM SEDIMENT INVESTIGATION/WA

APPENDIX T

REFERENCES AND CONTACTS

APPENDIX T

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Aberle, B. 2005. Personal communication on May 17, 2005 between D. Potter (Natural Resource Group, Inc.) and B. Aberle (WSDOT Transportation Permit Efficiency and Accountability Committee Implementation Coordinator).

Adams, J. 1992. Paleoseismology: A Search for Ancient Earthquakes in Puget Sound. Science, v. 258, p. 1592-1593.

Aitkin, K. 2003. Washington State Unionid Mussel Distribution Database. Workshop on the Fresh Water Mussels of the Pacific Northwest. U.S. Fish and Wildlife Service, Columbia River Fisheries Program, Vancouver, Washington.

AMEC. 2001. Report of Field Visit to MP 1434.0, MP 1434.5, and the Arlington Dairy (MPs 1423.55-1423.90).

American Gas Association. 1986. "An Analysis of Reportable Incidents for Natural Gas Transportation and Gathering Lines 1970 Through June 1984." NG-18 Report No. 158, Pipeline Research Committee of the American Gas Association. D.J. Jones, G.S. Kramer, D.N. Gideon, and R.J. Eiber.

Anderson, P.G. 1996. Sediment generation from forestry operations and associated effects on aquatic ecosystems. Proceedings of the Forest-Fish Conference: Land Management Practices Affecting Aquatic Ecosystems, May 1-4, 1996. Calgary, Alberta.

Ashley, K.I., and P.A. Slaney. 1997. Accelerating Recovery of Stream, River and Pond Productivity by Low-level Nutrient Replacement. Pages 13-1 to 13-24, in P.A. Slaney and D. Zaldokas (editors). Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No. 9. British Columbia Watershed Restoration Program, Ministry of Environment, Lands and Parks, and Ministry of Forests. Vancouver, B.C.

Babakaiff, S., D. Hay, and C. Fromouth. 1997. Rehabilitating Stream Banks. Pages 2-1 to 1-18, in P.A. Slaney and D. Zaldokas (editors). Fish Habitat Rehabilitation Procedures Watershed Restoration Technical Circular No. 9. British Columbia Watershed Restoration Program, Ministry of Environment, Lands and Parks, and Ministry of Forests. Vancouver, B.C.

Baddaloo, E.G. 1978. An Assessment of Effects of Pipeline Activity in Streams in the Durham and Northumberland Counties of Ontario. Journal of Canadian Society of Petroleum Geologists 4:2-10.

Bakun, W.H., R.A. Haugerud, M.G. Hopper, and R.S. Ludwin. 2002. The December 1872 Washington State Earthquake. Bulletin of the Seismological Society of America, v. 92, no. 8, p. 3239-3258.

Bethel, J., and K. Neal. 2003. Stream Enhancement Project; a King County Perspective. Pages 394-421 in D. R. Montgomery, S. Bolton, D.B. Booth, and L. Wall (eds.), Restoration of Puget Sound Rivers. University of Washington Press, Seattle, WA.

Binford, L.C., B.G. Elliott, and S.W. Singer. 1975. Discovery of a Nest and the Downy Young of the Marbled Murrelet. The Wilson Bulletin 87:303-440.

Bloodgood, J. 2004. Personal communication on September 21, between K. Knudsen (Natural Resource Group, Inc.) and J. Bloodgood (Snohomish County Traffic Engineer).

Booth, D.B., K.G. Troost, and S.A. Shimel. 2003. Landfall of the Seattle Fault Zone, West Seattle Washington. Geological Society of America Annual Meeting, Seattle, Washington. Paper No. 197-8.

Breteler, R.J., P.D. Boehm, J.M. Neff, and A.G. Requejo. 1985. Acute Toxicity of Drilling Muds Containing Hydrocarbon Additives and Their Fate and Partitioning Among Liquid, Suspended and Solid Phases. Battelle, Massachusetts. Health and Environmental Affairs Department Report DR9, American Petroleum Institute.

Brewer, D. 2004. Personal communication on September 21, between K. Knudsen (Natural Resource Group, Inc.) and D. Brewer (Pierce County Public Works – Traffic Engineering).

Bucknam, R.C., B.L. Sherrod, and G. Elfendahl. 1999. A Fault Scarp of Probable Holocene Age in the Seattle Fault Zone, Baindridge Island, Washington. Seismological Research Letters, v. 70, p. 233.

California State Fire Marshall. 1993. Hazardous Liquid Pipeline Risk Assessment. Sacramento, CA.

Cassidy, K.M., C.E. Grue, M.R. Smith, and K.M. Dvornich (editors). 1997. Washington State Gap Analysis – Final Report. Volumes 1-5. Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Washington.

Cederholm, C. J., L. G. Dominguez, and T. W. Bumstead. 1997. Rehabilitating Stram Channels and Fish Habitat Using Large Woody Debris. Pages 8-1 to 8-28, in P.A. Slaney and D. Zaldokas (editors). Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No. 9. British Columbia Watershed Restoration Program, Ministry of Environment, Lands and Parks, and Ministry of Forests. Vancouver, B.C.

CH2M Hill. 1994. Final Environmental Impact Statement. Stationing of Mechanized or Armored Combat Forces at Fort Lewis, Washington. Prepared for the U.S. Army Corps of Engineers, Mobile, Alabama.

Chase, S. 1998. Road to Recovery Salmon Restoration: the Regional Approach. Pages 140-142 in G.L. Evink, P.A. Garrett, D. Zeigler, and J. Berry (editors). Proceedings of the International Conference on Wildlife Ecology and Transportation. USDOT-Federal Highway Administration. Washington, D.C.

Comer, R.D. .1982. Understanding secondary effects of development on wildlife resources in mitigation planning. Pages 16-31 in Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute Technical Publication No. 14. Boulder, CO.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. Reprint from California Fish and Game. Vol. 47, No. 2. California Department of Fish and Game, Inland Fisheries Branch. Sacramento, CA. 45 pp.

COSEWIC. 2002. COSEWIC assessment and update status report on the Salish Sucker Catostomus sp in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 27 pp.

Crabtree, A.F. 1984. Resolving Conflicts Between Two Natural Resource User Groups: Pipeline Rights Of Way and Off-Road Vehicles. Pages 472-487 in A.F. Crabtree (editor). Proceedings of the Third International Symposium on Environmental Concerns in Rights-Of-Way Management. Mississippi State University, Mississippi State, MS.

Dragovich, J.D., D.K. Norman, R.AA. Haugerud, and P.T. Pringle. 1997. Geologic Map and Interpreted Geologic History of the Kendall and Deming 7.5-minute Quadrangles, Western Whatcom County, Washington. Washington State Department of Natural Resources, Division of Geology and Earth Resources. Open File Report 97-2, 39 p., 3 plates.

Elastec. 2005. American Marine for Innovative Environmental Products. http://www.turbiditycurtains.com.

ENSR International. 2000. Final Integrated Natural Resources Management Plan. Contract No. DACA67-97-D-1004, Delivery Order No. 17. Report Prepared for the Department of the Army, Fort Lewis, Washington, Redmond, WA.

ENSR International. 2003. Final Northern Spotted Owl Survey 2002-2003 Report. U.S. Army Public Works, Fort Lewis, WA.

ENSR International. 2004. 2003 Mazama Pocket Gopher Field Surveys at Fort Lewis, Washington, Final Report. U.S. Army Public Works, Fort Lewis, WA.

Federal Energy Regulatory Commission. 2002a. Final Environmental Impact Statement/Environmental Impact Report: Kern River 2003 Expansion Project. Washington, D.C.

Federal Energy Regulatory Commission: 2002b. Final Environmental Impact Statement: Georgia Strait Crossing Project. Washington, D.C.

Federal Register. 1994. Volume 59, July 13.

Federal Register. 2002. Volume 67, Number 151, August 6. Rules and Regulations, Page 50835.

Fisheries and Oceans Canada. 1999. Fraser River Chinook Salmon. DFO Science Stock Status Report D6-11.

Fraser, J.D., L.D. Fenzel, and J.E. Mathisen. 1985. The Impact of Human Activities on Breeding Bald Eagles in North-Central Minnesota. Journal of Wildlife Management 49:585-592.

Froedge, D.T. 1980. Blasting Effects on Water Wells. Philip R. Berger & Associates, Inc. Pittsburgh, Pennsylvania.

Gartman, D.K. 1984. The Impact of a Pipeline Crossing on the Benthos of a Pennsylvania Trout Stream. Pages 461-471 in A.E. Crabtree (editor). Proceedings of the Third International Symposium on Environmental Concerns in Rights-of-way Management. Mississippi State University, Mississippi State, MS.

Gas Research Institute. 1998. Sediment Entrainment due to Watercourse Crossing Construction. Topical Report. Prepared by M.J. Bender. April 1998.

Golder Associates Inc. 2004a. Capacity Replacement Project HDD Geotechnical and Feasibility Assessment, Whatcom, Skagit, Snohomish, King, Pierce, and Thurston Counties, Washington. Golder Project No. 043-1116.010. June 8, 2004.

Golder Associates Inc. 2004b. Capacity Replacement Project Geohazards, Whatcom, Skagit, Snohomish, King, Pierce, and Thurston Counties, Washington. Golder Project No. 043-1116.110. July 20, 2004.

Golder Associates Inc. 2004c. Capacity Replacement Project Stream Crossings Scour and Erosion Assessment, Whatcom, Skagit, Snohomish, King, Pierce, and Thurston Counties, Washington. Golder Project No. 043-1116.000. July 30, 2004.

Golder Associates Inc. 2005. Capacity Replacement Project Geotechnical Investigation of the Muck Creek and South Creek Crossings, Pierce County, Washington. Golder Project No. 043-1116.006. January 12, 2005.

Gower, H.D., J.C. Yount, and R.S. Crosson. 1985. Seismotectonic Map of the Puget Sound Region, Washington. U.S. Geological Survey Map I-1613.

Grubb, T.L., W.W. Bowerman, J.P. Giesy, and G.A. Dawson. 1992. Responses of Breeding Bald Eagles, Haliaeetus leucocephalus, to Human Activities in Northcentral Michigan. The Canadian Field-Naturalist 106:443-453.

Haas, G.R., and J.D. McPhail. 1991. Systematics and Distributions of Dolly Varden (Salvelinus malma) and Bull Trout (Salvelinus confluentus) in North America. Canadian Journal of Fisheries and Aquatic Science 48:2191-2211.

Hammond, E.H. 1965 [1970]. Physical Subdivisions [of the United States] in The National Atlas of the United States of America. U.S. Geological Survey, p. 61, scale 1:17,000,000.

Hard, J.J., R.G. Kope, W.S. Grant, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1996. Status Review of Pink Salmon from Washington, Oregon, and California. U.S. Department of Commerce NOAA Technical Memorandum NMFS-NWFSC-25.

Harp, B. 2004. Personal communication in June between PIC Technologies, Inc. and B. Harp (Hydrogeologist, Tacoma Pierce County Health Department, Source Protection Program).

Hartman, W.A. and D.B. Martin. 1984. Effect of Suspended Bentonite Clay on the Acute Toxicity of Glyphosate to Daphnia pulex and Lemna minor. Bulletin of Environmental Contamination and Toxicology 33:355-361.

Healey, M.C. 1991. Life History of Chinook Salmon. Pages 311 to 394 in C. Groot and L. Margolis (editors). Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, BC.

Hicks, M. 2005. Personal communication on January 26, between M. Bloomstran (Golder Associates Inc.) and M. Hicks (Washington State Department of Ecology, Water Quality Program).

Higgs, D.A., J.S. MacDonald, C.D. Levings, and B.S. Dosanjh. 1995. Nutrition and Feeding Habits in Relation to Life History Stage. In C. Groot, L. Margolis, and W.C. Clarke (editors). Physiological Ecology of Pacific Salmon. University of British Columbia Press, Vancouver, BC.

Hoblitt, R.P., J.S. Walder, C.L. Driedger, K.M. Scott, P.T. Pringle, and J.W. Vallance. 1998. Volcano Hazards from Mount Rainier, Washington, Revised 1998. U.S. Geological Survey Open File Report 98-428, 11p.

Horkel, J.D., and W.D. Pearson. 1976. Effects of Turbidity on Ventilation Rates and Oxygen Consumption of Green Sunfish, Lepomis cyanellus. Transactions of the American Fisheries Society 105:107-113.

Interstate Natural Gas Association of America. 2001. INGAA Foundation Natural Gas Pipeline Impact Study. Washington D.C.

Isaacs, F.B., R.G. Anthony, and R.J. Anderson. 1983. Distribution and productivity of nesting bald eagles in Oregon, 1978-1982. The Murrelet 64:33-38.

Johnson, K. 2004. Personal communication in September between PIC Technologies, Inc. and K. Johnson (King County Department of Natural Resources).

Johnson, N.P. 1990. Nesting Bald Eagles (Haliaeetus leucocephalus) in Urban Areas of Southeast Alaska: Assessing Highway Construction and Disturbance Impacts. Transportation Research Record 1279:60-68.

Johnson, S.Y., S.V. Dadisman, D.C. Mosher, R.J. Blakely, and J.R. Childs. 2001. Active Tectonics of the Devils Mountain Fault and Related Structures, Northern Puget Sound Lowland and Eastern Strait of Juan de Fuca Region, Pacific Northwest. U.S. Geological Survey Professional Paper 1643, 45 p., 2 plates.

Johnston, D. 2005. Personal communication on January 27, between A. Davis (Natural Resource Group, Inc.) and D. Johnston (Natural Resources Branch Chief, Environmental and Natural Resources Division, Fort Lewis Military Reservation).

Jones, D. J., and R. J. Eiber. 1992. An Analysis of Reportable Incidents for Natural Gas Transmission and Gathering Lines, 1984 through 1990. Battelle Laboratories, Chicago, IL.

Kelsey, H.M., B.L. Sherrod, and S.Y. Johnson. 2003. A Late Holocene Earthquake on Central Whidbey Island: Surface Folding Above a Blind Fault. Geological Society of America Abstracts with Programs, v. 35, n. 6, p 479.

Kerwin, J. 1999. Salmon and Steelhead Habitat Limiting Factors, Water Resource Inventory Area 11 – Nisqually Watershed. Washington State Conservation Commission, Olympia, WA.

King County, Noxious Weed Control Board. 2004. Noxious Weed List. http://dnr.metrokc.gov/wlr/lands/weeds/weedlist.cfm.

Knight, R.L., and S.K. Knight. 1984. Response of Wintering Bald Eagles to Boating Activity. Journal of Wildlife Management 48:999-1004.

Laurie, T. 2004. Telephone communication on October 28, between S. Patti (Natural Resource Group, Inc.) and T. Laurie (Tribal Liaison, Washington State Department of Ecology).

Maki Corporation. 2004a. Compressor Station Noise Study, Capacity Replacement Project, Chehalis, Rev.1. October.

Maki Corporation. 2004b. Compressor Station Noise Study, Capacity Replacement Project, Washougal. August.

Marshall, D.B. 1988a. Status of the Marbled Murrelet in North America with a Special Emphasis on Populations in California, Oregon, and Washington. U.S. Fish and Wildlife Service Biological Report 88(30).

Marshall, D.B. 1988b. The Marbled Murrelet Joins the Old-Growth Forest Conflict. American Birds 42:202-212.

Marshall, D.B. 1989. The Marbled Murrelet. Pages 435-455 in Audubon Wildlife Report 1989/1990. Academic Press, Inc. San Diego, CA.

McCullough, D.A. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. Environmental Protection Agency, Region 10, Seattle, WA.

McGarigal, K., R.G. Anthony, and F.B. Isaacs. 1991. Interactions of Humans and Bald Eagles on the Columbia River Estuary. Wildlife Monographs 115:1-47.

McKay, D.T. Jr., D.K. Norman, M.A. Shawver, and R.F. Teissere. 2001. Directory of Washington Mines. Washington State Department of Natural Resources, Division of Geology and Earth Resources. Information Circular 94.

McKenzie-Johnson, A.S. 2004. Kinematics of the Swift Creek Landslide, Northwest Washington. Master's Thesis, Western Washington University, Bellingham, Washington.

Migratory Bird Management, Arlington, Virginia. 2002. Birds of Conservation Concern. http://migratorybirds.fws.gov/reports/bcc2002.pdf.

Miller, C. 2004. Personal communication in June between PIC Technologies, Inc. and C. Miller (Whatcom County Health Department).

Moen, W.S. 1978. Mineral Resource Maps of Washington. Washington Division of Geology and Earth Resources, GM-22, 4 p., 4 plates.

Mutrie, D.F., and I. F.H. Scott. 1984. Environmental Evaluation of Water Crossing Techniques for Pipeline Construction in Canada. Pages 508-517 in A.E. Crabtree (editor). Proceedings of the Third International Symposium on Environmental Concerns in Rights-of-way Management. Mississippi State University, Mississippi State, MS.

Naslund, N.L. 1993. Why Do Marbled Murrelets Attend Old-Growth Forest Nesting Areas Year-Round? The Auk 110:594-602.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1997. Magnuson-Stevens Act Provision: Essential Fish Habitat (EFH). Federal Register 62(244):66531-66559.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1999a. Final Rule: Endangered and Threatened Species; Threatened Status for Three Chinook Salmon Evolutionarily Significant Units in Washington and Oregon, and Endangered Status for One Chinook Salmon ESU in Washington. Federal Register 64(56):14308-14328.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1999b. Endangered and Threatened Wildlife and Plants; Definition of "Harm." Federal Register 64(215):60727-60731.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2000. Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California. Federal Register 65(32):7764-7787

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2003. Proposed Rule: Advance Notice of Proposed Rulemaking to Designate Critical Habitat for 20 Listed Evolutionarily Significant Units of Pacific Salmon and Steelhead. Federal Register 698(188):55926-55932

National Park Service. 1998a. Wolves in the North Cascades: Questions and Answers. North Cascades National Park website: http://www.nps.gov/noca/wolf.htm.

National Park Service. 1998b. Threatened and Endangered Species. Grizzly Bear. North Cascades National Park website: http://www.nps.gov/noca/treas4-6.htm.

Nelson, A.R., S.Y. Johnson, S.K. Pezzopane, R.E. Wells, H.M. Kelsey, B.L. Sherrod, R.D. Koehler, L.A. Bradley, R.C. Bucknam, W.T. Laprade, J.W. Cox, and C.F. Narwold. 2000. Postglacial and Late Holocene Earthquakes on the Toe Jam Strand of the Seattle Fault, Bainbridge Island, Washington. Geological Society of America Cordilleran Section Meeting, Vancouver, B.C. April 27-29, 2000.

Office of Pipeline Safety, Research and Special Programs Administration: 49 CFR 192.761-Definitions. http://www.access.gpo.gov/nara/cfr/waisidx_03/49cfr192_03.html.

Pacific Fishery Management Council. 1999. Amendment 14 to the Pacific Coast Salmon Plan Appendix A. Identification and Description of Essential Fish Habitat, Adverse Impacts, and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council. Portland, OR.

Paton, P.W.C., C.J. Ralph, H.R. Carter, and S.K. Nelson. 1990. Surveying Marbled Murrelets at Inland Forested Sites: a Guide. USDA Forest Service General Technical Report PSW-120.

Pearson, S.F. 2003. Breeding Phenology, Nesting Success, Habitat Selection, and Census Methods for the Streaked Horned Lark in the Puget Lowlands of Washington. Washington State Department of Natural Resources, Olympia, WA.

Pierce County. 2001. Wellhead Protection Areas, Clover/Chambers Creek Basin, DRASTIC zones boundary provided to PIC Technologies, Inc by Pierce County GIS Center in August.

Pierce County, Noxious Weed Control Board. 2004. Noxious Weed List. http://piercecountyweedboard.wsu.edu/weedlist.html.

Reed, P., and C. Wood. 1991. Marbled Murrelet Chick and Eggshell Fragments from Inland Washington. The Murrelet 72:77-78.

Reid, S.M., and P.G. Anderson. Undated. Effects of Sediment Released During Open-Cut Pipeline Water Crossings. http://www.alliancepipeline.com/corporate profile/0070 Environment/c Images/c OpenCutCrossingPaper.pdf.

Reid, S.M., and P.G. Anderson. 1999. Effects of Sediment Released During Open-cut Pipeline Water Crossings. Canadian Water Resources Journal 24: 23-39.

Reid, S.M., F. Ade, and S. Metikosh. 2004. Sediment Entrainment During Pipeline Water Crossing Construction: Predictive Models and Crossing Method Comparison. Journal of Environmental Engineering and Science 3:81-88.

Reid, S.M., S. Stoklosar, S. Metikosh, and J. Evans. 2002. Effectiveness of Isolated Pipeline Crossing Techniques to Mitigate Sediment Impacts on Brook Trout Streams. Water Quality Research Journal of Canada 37:473-488.

Ritter, P.W. 1984. Water Quality Concerns Associated with Pipeline Stream Crossings. Pages 447-456 in A.E. Crabtree (editor). Proceedings of the Third International Symposium on Environmental Concerns in Rights-of-way Management. Mississippi State University, Mississippi State, MS.

Romin, L.A., and J.A. Muck. 1999. Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances. U.S. Fish and Wildlife Service, Utah Field Office, Salt Lake City, UT.

SalmonScape; 2004. WDFW Salmon and Steelhead Habitat Inventory and Assessment Program. http://wdfw.wa.gov/mapping/salmonscape.

Sauer, J. R., J. E. Hines, and J. Fallon. 2003. The North American Breeding Bird Survey, Results and Analysis 1966-2002. Version 2003.1, U.S. Geological Survey, Patuxent Widlife Research Center, Laurel, MD.

Scarborough, G.C., and T. Robertson. 2002. Evaluation of low technology large woody debris as a technique to augment fish habitat in streams crossed by transmission corridors. Pages 777-787 in J.W. Goodrich-Mahoney, D.F. Mutrie, and C.A. Guild (eds.), The Seventh International Symposium on Environmental Concerns in Rights-of-Way Management. Elsevier, New York.

Schasse, H.W., M.L. Koler, N.A. Eberle, and R.A. Christie. 1994. The Washington State Coal Mine Map Collection: a Catalog, Index, and User's Guide. Washington State Department of Natural Resources, Division of Geology and Earth Resources. Open File Report 94-7.

Scott, K.M., W. Hildreth, and C. Gardner. 2000. Mount Baker – Living With an Active Volcano. U.S. Geological Survey Fact Sheet 059-00.

Seattle Audubon Society. 2002. Bird Web. http://www.birdweb.org.

Shaw, P.A. and J.A. Maga. 1943. The effect of mining silt on yield of fry from salmon spawning beds. California Fish and Game. 29(1): 29-41.

Sherrod, B.L., T.M. Brocher, C.S. Weaver, R.C. Bucknam, R.J. Blakely, H.M. Kelsey, A.R. Nelson, and R.A. Haugerud. 2003. Evidence for a Late Holocene Earthquake on the Tacoma Fault, Puget Sound, Washington. Geological Society of America Annual Meeting.

Siskind, D.E. and R.R. Fumanti. 1974. Blast-Produced Fractures in Lithonia Granite. U.S. Department of the Interior, Bureau of Mines.

Smith, C.J. 2002. Salmon and Steelhead Habitat Limiting Factors in WRIA 1, the Nooksack Basin. Washington State Conservation Commission, Lacey, WA.

Smith, M.R., P.W. Mattocks, Jr., and K.M. Cassidy. 1997. Breeding Birds of Washington State. Seattle Audubon Society Publications in Zoology Number 1. Seattle, Washington.

Snohomish County, Department of Public Works. 2004. Noxious Weed List. http://www.co.snohomish.wa.us/publicwk/roads/Roadsprograms/Weed%20Classes.htm.

Sprague, J.B., and W.J. Logan. 1979. Separate and Joint Toxicity to Rainbow Trout of Substances used in Drilling Fluids for Oil Exploration. Environmental Pollution 19:269-281.

Stalmaster, M.V. 1987. The Bald Eagle. Universe Books, New York, New York.

Stalmaster, M.V. and ENSR International. 2003. Status of the Wintering and Nesting Bald Eagle Population during 2003 on Fort Lewis, Washington. Final Report. U.S. Army Public Works, Fort Lewis, WA.

Stalmaster, M.V. and J.R. Newman. 1978. Behavioral Responses of Wintering Bald Eagles to Human Activity. Journal of Wildlife Management 42:506-513.

Steucke, P. 2005. Comment received on the draft EIS for the Capacity Replacement Project from P. Stuecke (Chief, Environmental and Natural Resources Division, Department of the Army, Fort Lewis).

Stinson, D.W. 2001. Washington State Recovery Plan for the Lynx. Washington Department of Fish and Wildlife, Olympia, WA.

Stinson, D.W., J.W. Watson, and K.R. McAllister. 2001. Draft Washington State Status Report for the Bald Eagle. Washington Department of Fish and Wildlife. Olympia, WA.

Stone, J. 2003. Distribution and Habitat Use of the Western Pearlshell Mussel in Cedar Creek, Washington. Workshop on the Fresh Water Mussels of the Pacific Northwest. U.S. Fish and Wildlife Service, Columbia River Fisheries Program, Vancouver, Washington.

The Coot Company. 2004. Northwest's Stream and Wetland Delineation Report.

Thomas, T.B., and A.B. Carey. 1996. Endangered, Threatened, and Sensitive Plants of Fort Lewis, Washington: Distribution, Mapping, and Management Recommendations for Species Conservation. Northwest Science 70:148-163.

Thurston County Critical Areas. 1996. Part 500 Aquifer Recharge Areas, June.

U.S. Census Bureau. 1996. "Statistical Abstract of the United States 118th Edition."

U.S. Census Bureau. 2000a. Census 2000: MapStats/County Profile. http://www.fedstats.gov/qf.

U.S. Census Bureau. 2000b. 2000 Census of Population and Housing. Summary Social, Economic and Housing Characteristics. PHC-2. http://www.census.gov/prod/cen2000/.

U.S. Census Bureau. 2000c. 2000 Census of Population and Housing. Population and Housing Unit Counts. PHC-3. http://www.census.gov/prod/cen2000/.

U.S. Census Bureau. 2000d. Census 2000 Summary File 1, Matrices P1 and P7. http://www.factfinder.census.gov.

U.S. Census Bureau. 2000e. Census 2000 Summary File 3, Matrix P19. http://www.factfinder.census.gov.

U.S. Census Bureau. 2000f. Census 2000 Summary File 3, Matrix P53. http://www.factfinder.census.gov.

U.S. Census Bureau. 2000g. Census 2000 Summary File 3, Matrix P87. http://www.factfinder.census.gov.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1973. Soil Survey of King County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1979. Soil Survey of Pierce County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1983. Soil Survey of Snohomish County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1989. Soil Survey of Skagit County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1990. Soil Survey of Thurston County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1992. Soil Survey of Whatcom County Area, Washington.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2003. National Soil Survey Handbook, title 430-VI. http://soils.usda.gov/technical/handbook/.

U.S. Department of Energy. 2003. Annual Coal Report. Available on-line at: http://www.eia.doe.gov/cneaf/coal/page/acr/table2p3.html.

U.S. Department of the Army. 1994a. Final Environmental Impact Statement. Stationing of Mechanized or Armored Combat Forces at Fort Lewis, Washington. PW, Fort Lewis, WA.

U.S. Department of the Army. 1994b. Northern Spotted Owl Habitat Management Plan for Designated Conservation Area WA-43 Fort Lewis, Washington. PW, Fort Lewis, WA.

U.S. Department of Transportation. 1987. "Annual Report on Pipeline Safety - Calendar Year 1987."

U.S. Department of Transportation, Hazardous Materials Information System. 2004. Incident year data, 1993 through 2003. http://hazmat.dot.gov/files/hazmat/hmisframe.htm.

U.S. Department of Transportation, Office of Pipeline Safety. 1987. Annual Report on Pipeline Safety – Calendar Year 1987. Washington D.C.

U.S. Department of Transportation, Office of Pipeline Safety. 2004. Statistics for Natural Gas Transmission Pipelines. http://primis.rspa.dot.gov/pipelineInfo/statistics.htm.

U.S. Environmental Protection Agency. 1986. Quality Criteria for Water. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.

U.S. Environmental Protection Agency. 2001. National Management Measures to Control Nonpoint Source Pollution from Forestry. Draft. Environmental Protection Agency, Office of Water. Washington, D.C.

U.S. Environmental Protection Agency. 2004. Permit Compliance System, WPA Office of Water, Washington, D.C. Online at http://www.epa.gov.enviro, updated July, 2004.

U.S. Fish and Wildlife Service. 1986. Pacific States Bald Eagle Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 1987. Northern Rocky Mountain Wolf Recovery Plan. U.S. Fish and Wildlife Service, Denver, CO.

U.S. Fish and Wildlife Service. 1991. Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Marbled Murrelet in Washington, Oregon and California. Federal Register 56(119):28362-28367.

U.S. Fish and Wildlife Service. 1992a. Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Northern Spotted Owl; Final Rule. Federal Register 57(10):1796-1838.

U.S. Fish and Wildlife Service. 1992b. Critical Habitat for the Northern Spotted Owl; Maps and Legal Descriptions; Washington. U.S. Fish and Wildlife Service, Portland, OR.

U.S. Fish and Wildlife Service. 1992c. Recovery Plan for the Northern Spotted Owl – Final Draft. U.S. Fish and Wildlife Service, Portland, OR.

U.S. Fish and Wildlife Service. 1993a. Grizzly Bear Recovery Plan. U.S. Fish and Wildlife Service, Missoula, MT.

U.S. Fish and Wildlife Service. 1993b. Proposed Rule and Notice of Petition Finding: Endangered and Threatened Wildlife and Plants; Proposed Listing of Water Howellia (Howellia aquatilis) as Threatened. Federal Register 58:19795.

U.S. Fish and Wildlife Service. 1996. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for the Marbled Murrelet; Final Rule. Federal Register 61(102):26256-26320.

U.S. Fish and Wildlife Service. 1997. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Castilleja levisecta (Golden Paintbrush). Federal Register 62(112):31740-31748.

U.S. Fish and Wildlife Service. 1998a. Recovery Plan for Marsh Sandwort (Arenaria paludicolu) and Gambel's Watercress (Rorippa gambelii). U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

U.S. Fish and Wildlife Service. 1998b. A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale (DRAFT). Prepared by USFWS, February 1998

U.S. Fish and Wildlife Service. 1999a. Endangered and Threatened Wildlife and Plants; Proposed Rule to Remove the Bald Eagle in the Lower 48 States from the List of Endangered and Threatened Wildlife. Federal Register 64(128):36453-36464.

U.S. Fish and Wildlife Service. 1999b. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Conterminous United States; Final Rule. Federal Register 64(210):58910-58933.

U.S. Fish and Wildlife Service. 2000a. Recovery Plan for the Golden Paintbrush (Castilleja levisecta). U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

U.S. Fish and Wildlife Service. 2000b. Biological Assessments and Section 7 of the Endangered Species Act. FWS, Western Washington Office, Lacey, WA.

U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pp. http://migratorybirds.fws.gov/reports/bcc2002.pdf.

U.S. Fish and Wildlife Service. 2004a. Letter dated May 11, from K. Berg (Manager, Western Washington Fish and Wildlife Office) to A. Reeve (PIC Technologies, Inc.).

U.S. Fish and Wildlife Service. 2004b. Proposed Rule: Proposed Designation of Critical Habitat for the Jarbidge River, Coastal-Puget Sound, and Saint Mary-Belly River Populations of Bull Trout. Federal Register 69(122):35768-35857.

U.S. Geological Survey. 1994. Ground Water Atlas of the United States. Hydrogeologic Atlas 730-H, Segment 7. Reston, Virginia.

U.S. Geological Survey. 2002a. Minerals Yearbook: The Mineral Industry of Washington. Available on-line at http://minerals.usgs.gov/minerals/pubs/state/2002/wastmyb02.pdf.

U.S. Geological Survey. 2002b. 2002 National Seismic Hazard Maps, Western U.S. Maps. Available on-line at http://eqhazmaps.usgs.gov/html/wus2002.html.

U.S. Geological Survey. 2004. Earthquake Hazards Program. Available on-line at http://eqhazmaps.usgs.gov/index.html.

Vandersypen, R. 2004. Personal communication on October 6, between J. Lee (Natural Resource Group, Inc.) and R. Vandersypen (Whatcom County Traffic Engineer).

Villasenor, A., and H. Benz. 1999. Tectonic Analysis of the Northern Cascadia Subduction Zone in Western Washington State Using Velocity and Deformation Models. Seismological Society of America.

Wahbeh, H. 2005. E-mail communication on February 25, between T. Powell (Northwest Pipeline Corporation) and H. Wahbeh (Anteon Corporation).

Wait, M. 2003. Freshwater Mussel Bed Size, Density, and Population Age Structure in Upper Bear Creek, King County, Washington. Workshop on the Fresh Water Mussels of the Pacific Northwest. U.S. Fish and Wildlife Service, Columbia River Fisheries Program, Vancouver, Washington.

Wait, M. 2004. Bear Creek Mussel Studies 2003. Proceedings of the 2nd Annual Workshop on the Fresh Water Mussels of the Pacific Northwest. Pacific Northwest Native Freshwater Mussel Workgroup, Vancouver, Washington.

Waitt, R.B., L.G. Mastin, and J.E. Beget. 1995. Volcanic Hazard Zonation for Glacier Peak Volcano, Washington. U.S. Geological Survey Open File Report 95-499.

Washington Department of Fish and Wildlife. 1998. Washington State Salmonid Stock Inventory (SaSI). Bull Trout/Dolly Varden. Olympia, Washington.

Washington Department of Fish and Wildlife. 2000. Washington State Salmonid Stock Inventory (SaSI). Coastal Cutthroat Trout. Olympia, WA.

Washington Department of Fish and Wildlife. 2003. Priority Habitats and Species Maps. Washington Department of Fish and Wildlife, Priority Habitats and Species Division. Olympia, WA. Data output for PIC Technologies, Inc.

Washington Department of Fish and Wildlife. 2004a. Priority Habitats and Species, Priority Habitats. http://wdfw.wa.gov/hab/phshabs.htm.

Washington Department of Fish and Wildlife. 2004b. Priority Habitats and Species, What is the PHS List? http://wdfw.wa.gov/hab/phslist.htm.

Washington Department of Fish and Wildlife. 2005a. Personal communication on January 12 between PIC Technologies, Inc. and G. Sprague (Washington Department of Fish and Wildlife).

Washington Department of Fish and Wildlife. 2005b. Personal communication on January 11 between PIC Technologies, Inc. and J. Haymes (Fisheries Biologist – Salmon Management Program).

Washington Department of Fish and Wildlife and Northwest Indian Fisheries Commission. 2004. Salmon and Steelhead Habitat Inventory and Assessment Program. Online at: http://wdfw.wa.gov/hab/sshiap/.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State Salmon and Steelhead Stock Inventory (SaSI). Washington Department of Fisheries, Olympia, WA.

Washington Department of Health. 2004a. EPA-Designated Sole Source Aquifers. ftp://ftp3.doh.wa.gov/geodata/layers/grpa.exe.

Washington Department of Health. 2004b. Wellhead Protection Areas. Available at: ftp://ftp3. doh.wa.gov/geodata/layers/grpa.exe.

Washington Forest Practices Board. 2000. Washington Forest Practices, Rules – WAC 222. April.

Washington Forest Practices Board. 2001. Permanent Forest Practices Rules – new, amended, or repealed sections of the rules. May 17, 2001.

Washington Natural Heritage Program. 2003. Geographic Information System. Data output for PIC Technologies, Inc.

Washington Natural Heritage Program. 2004. Washington Natural Heritage Program. http://www. dnr.wa.gov/nhp.

Washington State Conservation Commission. 1999. Salmon and Steelhead Habitat Limiting Factors. Water Resource Inventory Area 5 Stillaguamish Watershed. Washington State Conservation Commission, Olympia, WA.

Washington State Department of Community, Trade, and Economic Development. 2003. Critical Areas Assistance Handbook, Protecting Critical Areas Within the Framework of the Washington Growth Management Act.

Washington State Department of Community, Trade, and Economic Development. 2004. http://www. tourism.wa.gov.

Washington State Department of Ecology. 2001a. Managing Washington's Coast, Washington's Coastal Zone Management Program. Publication 00-06-029. February 2001.

Washington State Department of Ecology. 2001b. Groundwater Management Areas. http://www.ecy.wa.gov/services/gis/data/gw_wells/gwma.zip;
http://www.ecy.wa.gov/programs/eap/groundwater/index.html;
http://www.co.snohomish.wa.us/publicwk/swm/maps/

Washington State Department of Ecology. 2004a. Department of Water Resources - Northwest Region. Listing of groundwater supply wells. http://apps.ecy.wa.gov/welllog/extsearch.asp.

Washington State Department of Ecology. 2004b. Water Resources Program. Surface Water Rights Database. Data Request from PIC Technologies, Inc. June.

Washington State Department of Ecology. 2004c. Preliminary Draft of Washington State's Water Quality Assessment 2002/2004 303(d) List. Updated July, 2004. http://www.ecy.wa.gov/programs/wq/303d/2002/2002-index.html.

Washington State Department of Ecology. 2004d. How Ecology Regulates Wetlands. http://www.ecy.wa.gov/pubs/97112.pdf.

Washington State Department of Ecology. 2004e. Washington State Wetland Rating System for Western Washington. www.ecy.wa.gov/pubs/0406025.pdf.

Washington State Department of Ecology. 2004f. Appendix 8-C, Guidance on Widths of Buffers and Ratios for Compensatory Mitigation to be used with the Western Washington Wetland Rating System. http://www.ecy.wa.gov/programs/sea/bas_wetlands/vol2/Appendix%208-%20external%20review%20draft.pdf.

Washington State Department of Ecology. 2004g. Final Supplemental Environmental Impact Statement: Georgia Strait Crossing Project. Bellevue, Washington.

Washington State Department of Natural Resources. 1997. Final Habitat Conservation Plan. Washington State Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources. 2001. Forest Practices Board Manual Section 7. Guidelines for Riparian Management Zones. Washington State Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources and Bureau of Land Management. 1997 (+ updates). Field Guide to Selected Rare Vascular Plants of Washington. Washington State Department of Natural Resources, Olympia, Washington and USDI-Bureau of Land Management, Spokane, WA.

Washington State Noxious Weed Control Board. 1987. Washington Noxious Weed Laws, Chapter 17.10 RCW. http://www.nwcb.wa.gov/weed_laws/17-10.pdf.

Washington State Noxious Weed Control Board. 2003. Washington Noxious Weed Laws, Chapter 16-750 WAC. http://www.nwcb.wa.gov/weed_laws/16-750.2004.fm.pdf.

Washington State Office of Archaeology and Historic Preservation. 2004. Letter dated September 28 from R. Whitlam (State Archaeologist) to T. Powell (Williams Gas Pipeline).

Washington State Office of Archaeology and Historic Preservation. 2005a. Letter dated January 19 from R. Whitlam (State Archaeologist) to T. Powell (Williams Gas Pipeline).

Washington State Office of Archaeology and Historic Preservation. 2005b. Letter dated April 5 from R. Whitlam (State Archaeologist) to T. Powell (Williams Gas Pipeline).

Washington State Office of Archaeology and Historic Preservation. 2005c. Letter dated June 14 from R. Holter (Project Compliance Reviewer) to V. Button (Federal Energy Regulatory Commission).

Watson, J.W. and E.A. Rodrick. 2001. Washington Department of Fish and Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds.

Whatcom County. 2001. Natural Gas and Hazardous Liquid Pipeline Background Report. Whatcom County, Washington.

Whatcom County, Department Public Works. 2003. Noxious Weed List. http://www.co.whatcom.wa.us/publicworks/pdf/weeds/nw_weedlist2003.pdf.

Wickett, W.P. 1954. The oxygen supply to salmon eggs in spawning beds. Journal of the Fisheries Research Board Canada. 11(6): 933-953.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A Catalog of Washington Streams and Salmon Utilization. Volume 1, Puget Sound Region. Washington Department of Fisheries. Olympia, Washington.

Workforce Explorer: Labor Market Info through March 2004. http://www.workforceexplorer.com.

Yahoo! Yellow Pages. 2004. http://yp.yahoo.com.

Zollweg, J.E., and P.A. Johnson. 1989. The Darrington Seismic Zone in Northwestern Washington. Bulletin of the Seismological Society of America, Volume 79, Number 6.

APPENDIX U

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